AD-A149 607 COOPER RIVER REDIVERSION PROJECT LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA FISH HATCHERY(U) CORPS OF ENGINEERS CHARLESTON SC CHARLESTON DISTRICT JUL 80 1/2

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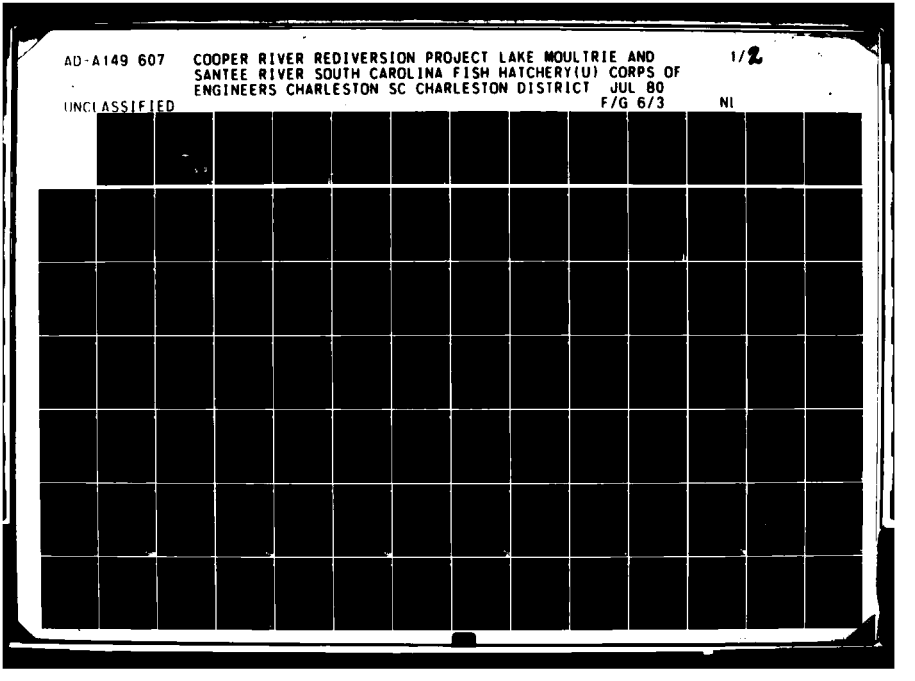

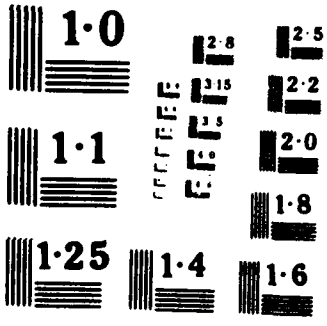
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DESIGN MEMORANDUM NO. 14

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER

SOUTH CAROLINA

FISH HATCHERY

U.S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
Charleston, South Carolina

PREPARED BY
BUCHART-HORN INCORPORATED
CONSULTING ENGINEERS & PLANNERS
WILLIAMSBURG, VIRGINIA

JULY, 1980

COPY NO. 52

SADEN-GP (11 Sep 80) 3rd Ind
SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

DA, South Atlantic Division, Corps of Engineers, 510 Title Building, 30 Pryor Street, SW, Atlanta, Georgia 30303 16 June 1981

TO: Commander, Charleston District, ATTN: SACEN-G

Information furnished is satisfactory.

FOR THE COMMANDER:

WILLIAM N. McCORMICK, JR., P.E.
Chief, Engineering Division

wd all incl

CF:
DAEN-CWE-BB w/10 cys incl

SACEN-G (11 Sep 80) 2nd Ind
SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

DA, Charleston District, Corps of Engineers, P. O. Box 919, Charleston, South Carolina 29402 13 May 1981

TO: Division Engineer, South Atlantic, ATTN: SADEN-GP

1. The following are in reference to SADEN-GP 1st Indorsement dated 18 December 1980.

a. Concur. See revised page 3.

b. Concur. See revised page 5.

c. Concur. Borings logs, test results and computations of allowable bearing capacity are attached for inclusion in Appendix E.

d. Asphalt shingles will be less expensive initially, however, shakes treated with penta offer the following substantial advantages:

(1) Architecturally more esthetic, blending into the building's surroundings.

(2) Practically maintenance free - should last for the life of the structure.

(3) More energy efficient. Due to their higher insulating value.

e. Water taken from the powerhouse dewatering wells is being sampled for determining water quality only. These wells are temporary and will not be available to supply the fish hatchery.

f. Results of water quality tests are provided as Appendix F.

g. Final well locations are as shown on plate 3. The second production well is to be 2,000 feet downstream and adjacent to the Government property line from the well shown on plate 3.

h. Concur.

i. Final design parameters are being coordinated with the local health departments. Design parameters will be submitted as requested in comment h.

j. Concur. See revised page 25.

k. Concur. Instructions in Exhibit 6 are incorrect, two rest rooms as shown on the drawings are required.

l. Concur.

m. Concur.

n. Concur.

SACEN-G (11 Sep 80) 2nd Ind 13 May 1981
SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

o. The design of this facility considers the traffic patterns to be similar to that of an industrial facility thus the development of a circular traffic pattern. A pattern such as this allows for parking, shipping, and fish handling to occur all at the same time. It is necessary for trucks to have access to the holding tank area for the delivery and return of the very large brood fish with a very minimum amount of handling. Recommend that this area be paved as shown on plate 3.

p. Concur.

q. The Owner prefers not to have any windows in the facility to minimize potential problems with vandalism in the facility.

r. The walls are constructed of eight (8") inch block, not four (4") inch. Wall section is drawn to indicate foamed insulation in core holes.

s. Concur.

t. The design does not require insulation in the roof in the storage areas and hatching room since these areas are unheated, however the cedar shake roof does have some insulation value. It does provide for insulation in the drop ceilings in the laboratory and kitchen areas, which are conditioned spaces.

u. Concur.

v. One-half (½") inch thick plywood sheathing conforms to BOCA requirements for loadings up to 65 pounds per square foot.

w. Concur. See revised page 22.

2. The following is in reference to DAEN-CWE-BB letter dated 13 February 1981 and SADEN-GP 1st Indorsement thereto.

Concur. First sentence of Appendix A, paragraph 2b will be deleted in its entirety. Second sentence of Appendix A, paragraph 2b will be revised to delete "and assignable," to make the State's interest consistent with the provisions of paragraph 4.

3. The fish hatchery site is in the process of being shifted 200 feet in a northeasterly direction. This is being done to avoid adverse impacts and conflicts with powerhouse construction. No rearrangement of the hatchery building and holding ponds will result. No significant design changes will be made and no additional project lands are required.

JACK J. LESEMANN
Chief, Engineering Division

3 Incl (13 cys)
1. Revised pages
2. New pages for Appendix E
3. Appendix F

SADEN-GP (13 Feb 81) 1st Ind
SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

DA, South Atlantic Division, Corps of Engineers, 510 Title Building, 30 Pryor Street, SW, Atlanta, Georgia 30303 27 February 1981

TO: District Engineer, Charleston, ATTN: SACEN-GP

Referred for appropriate action.

FOR THE DIVISION ENGINEER:

James W. Erwin Jr.

WILLIAM N. McCORMICK, JR.
Chief, Engineering Division

GP

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO ATTENTION OF:

DAEN-CWE-BB

13 February 1981

SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

Division Engineer, South Atlantic
ATTN: SADEN-GP

1. Reference 1st Indorsement SADEN-GP, 18 December 1980 on letter SACEN-GP, 11 September 1980, subject as above.

2. The comment in the following paragraph on the subject design memorandum is furnished for appropriate action.

3. Appendix A, paragraph 2b. This paragraph is not understood since the Government already owns the underlying fee. Also, we question whether it is prudent to convey assignable easements to the State since the facilities are to revert back to the Government if the State ceases the operation of the fish hatchery for a continuous period of three years.

FOR THE CHIEF OF ENGINEERS:

for Jack R. Thompson
LLOYD A. DUSCHA
Chief, Engineering Division
Directorate of Civil Works

SADEN-GP (11 Sep 80) 1st Ind
SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

DA, South Atlantic Division, Corps of Engineers, 510 Title Building, 30 Pryor Street, SW, Atlanta, Georgia 30303 18 December 1980

TO: District Engineer, Charleston, ATTN: SACEN-GP

The design memorandum on the Fish Hatchery is approved subject to the following comments:

a. The "Report of Necessity", page 3, appears to be incomplete. If subparagraph (a) is the extent of the needs being itemized, this paragraph should be integrated into Paragraph 6, as a continuation of the last sentence. A possible subparagraph (b) could provide engineering requirements such as water supply details.

b. Page 5, paragraph 14. The storm drainage criteria should discuss the following:

(1) The design storm for sizing the catch basin and side ditch.

(2) The hydraulic design of the side ditch, channel velocities and erosion control measure.

c. Page 10, paragraph 27.d. The boring which will be conducted to establish the bearing capacity for the design of the tank should be included in the D.M. along with a discussion of the results.

d. Page 7, paragraph 17.e. Question the need for split shake cedar shingle roof. An asphalt shingle roof would be more appropriate and cheaper too!

e. It is not clear what use is to be made of water discharged from the powerhouse dewatering wells as described in subparagraph (c), page 13, as the water supply for all hatchery needs are to be provided by other wells (page 14). This should be clarified.

f. Page 13, paragraph 31.c. Results of the testing program on the water discharge from the powerhouse dewatering wells which is currently being conducted should be included in the D.M. to verify whether or not treatment facilities will be necessary.

g. Page 14, paragraph 32.c. It is noted in this paragraph that the final design and location of the wells will be based on information contained in D.M. No. 6 as it relates to the underground water supply and on chemical tests of water currently being pumped at the powerhouse. The final design and location of the wells should be presented in the D.M.

h. Page 18, paragraph 43. The final design parameters for the disposal system should be submitted to SAD prior to submittal of plans and specifications. The submitted data should include percolation test results and design criteria for the distribution pipes and absorption trenches.

i. Page 18, paragraph 42. The subsurface investigations and analysis which will be conducted to provide the final design of the sanitary sewage disposal system should be presented in the D.M.

j. A section should be included describing operation and maintenance of the facility and providing Corps and State functions and responsibilities.

k. Architectural Plan, Plate 5. Plan shows two toilets. This violates instructions contained in Exhibit 6, paragraph c. which states that "One rest room will be provided". Coordinate.

l. Plate 9, Typical Well Section. If the wells are to be screened in both aquifers, then the characteristics of the individual strata in each aquifer should be considered in the design. (For example in design of the gravel pack).

m. Planter, Plate 10. Size of planter is excessive for number of designated plants as shown on Plate 10, Landscape Plan. Recommend extending gravel drain area two additional feet in width and planting material in this area. This would achieve the following: elimination of the need for an individual planter, rock used in drain could be also utilized as mulch for plant materials, project reduction in cost of approximately $8,875.

n. Page 5, paragraph 13 and Plate 10. Material used in planting beds; azaleas, cotoneasters, should be of relatively the same mature growth size. Care must be taken in selection of cotoneaster species because of the aggressive nature of some species. Suggest grouping of plants to reduce maintenance and to breakup symmetry.

o. Plate 3. The function of the asphalt paved area east of hatchery building is unclear. Justify need of paving from south corner of building to north corner of spawning area. This area covers approximately 4700 square feet.

p. Plate 3. Provide parking space for handicapped (1).

q. Plate 4 and Plate 5. Verify requirement for windows for natural light and/or ventilation. Particularly in kitchen and laboratory.

r. Plate 6. Verify lateral load on 4" exterior CMU wall.

s. Plate 6. If foam insulation is to be used. Do not use UREA

SADEN-GP (11 Sep 80) 1st Ind 18 December 1980
SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

FORMALDEHYDE. This product has been banned in several states as a health hazard.

t. Plate 6. Roof insulation should be shown.

u. Plate 6. Check use of ½" plywood roof sheathing for 24" truss spacing.

v. The agreement at the time of execution must have Section 221 certification added.

w. Page 22, paragraph 54. A comparison and explanation of the design memorandum cost estimate with the latest approved PB-3 should be given.

FOR THE DIVISION ENGINEER:

wd all incl

WILLIAM N. McCORMICK, JR.
Chief, Engineering Division

CF:
DAEN-CWE-BB, w/10 cys Incl

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT CORPS OF ENGINEERS
P.O. BOX 919
CHARLESTON SOUTH CAROLINA 29402

SACEN-GP

11 September 1980

SUBJECT: Cooper River Rediversion Project, Design Memorandum 14 - Fish Hatchery

Division Engineer, South Atlantic
ATTN: SADEN-GP

1. Transmitted are thirteen copies of the subject design memorandum, submitted for approval in accordance with the applicable provisions of EC 1110-2-193.

2. It is recommended that this design memorandum be approved as a basis for the preparation of construction plans and specifications for applicable portions of the project.

B. E. Stalmann

BERNARD E. STALMANN
LTC, Corps of Engineers
District Engineer

1 Incl (13 cys)
as

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDA COMPLETED

Title	Date Submitted	Design Memorandum No.
General Design Memorandum	Jan 72	1
General Design Memorandum, Supplement No. 1, Comparison of Alternative Plans	Oct 73	1
General Design Memorandum, Supplement No. 2, Requirements for Protection of Bushy Park	Feb 76	1
Turbines, Governors, and Generators	Jun 73	2
Entrance Channel in Lake Moultrie	Mar 74	3
Access Roads and Construction Facilities	May 74	4
Real Estate, Area 1	Sep 74	5
Real Estate, Area 2	Mar 77	5A
Dike Selection and Geology	May 75	6
Preliminary Design Report - Powerplant	Jan 76	7
Powerhouse Foundation Analysis	Feb 76	16
Relocation of Seaboard Coast Line Railroad Trestle	Jun 76	8
Intake and Tailrace Canals	Jul 76	9
Primary and Secondary Road Relocation	Apr 79	10
Utilities Relocation		11
Construction Materials	Mar 78	12
Cooling Water System	Dec 79	13
Fish Hatchery	Jul 80	14
Water Monitoring Plan	Dec 77	15

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 14

RELOCATION OF FISH HATCHERY

CONTENTS

TEXT

CONTENTS Contd

TEXT Contd

EXHIBITS

PLATES

APPENDIX

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

DESIGN MEMORANDUM NO. 14

NECESSITY AND PLAN FOR
RELOCATION OF FISH HATCHERY

PERTINENT DATA

DRAINAGE AREA	Square miles
Lake Moultrie	15,000
Lake Marion	14,700
RESERVOIR AREAS	Acre-feet
Maximum power pool	
Lake Moultrie	1,110,000
Lake Marion	1,450,000
Minimum power pool	
Lake Moultrie	450,000
Lake Marion	350,000
ELEVATIONS	Feet, msl
Top of dam	
Lake Moultrie	88.0
Lake Marion	88.0
Maximum water surface	
Lake Moultrie	75.2
Lake Marion	76.8
Top of gates	
Lake Moultrie	--
Lake Marion	76.8
Spillway crest	
Lake Moultrie	--
Lake Marion	63.0
Maximum power pool	
Lake Moultrie	75.2
Lake Marion	75.7
Minimum power pool	
Lake Moultrie	60.0
Lake Marion	60.0
Normal tailwater	
Lake Moultrie	7.2
Lake Marion	27.0
Minimum tailwater	
Lake Moultrie	-1.5
Lake Marion	26.0

PERTINENT DATA (Cont'd)

WILSON DAM (Forms Lake Marion)	
Completion date	23 March 1942
Length - miles	7.8
Height of spillway - feet	48
Spillway	
Design capacity - cfs	800,000
Length - feet	3,400
Gates	
Number	62
Size - feet	14 X 50
INTAKE AND TAILPACE CANALS	
Canal length - miles	9.4
Intake canal invert elevation - msl	50
Tailrace canal invert elevation - msl	0.0
Maximum operating tailwater elevation - msl	23.1
Maximum discharge - cfs	24,500
Maximum intake canal velocities - fps	3.2
Maximum Tailrace canal velocities - fps	7.6
Canal bottom width - feet	285
Canal side slopes	1 vertical to 3 horizontal
ENTRANCE CHANNEL IN LAKE MOULTRIE	
Channel length - feet	13,534
Channel invert - to station 74+34 - msl	65
Channel width - to station 89+34 - feet	1,500
Channel invert - from station 115+34 - msl	55
Channel width - from station 115+34 - feet	375
Maximum discharge - cfs	24,500
Maximum channel velocity - fps	3
Channel vertical to 3 horizontal	
EXCAVATION QUANTITIES	
Entrance channel	2,780,000 CY
Intake and tailrace canals	15,336,000 CY
CONSTRAINTS IN COOPER RIVER TO LAKE MOULTRIE	
Strawberry Landing railroad bridge - width - feet	33
Lock size at Pinopolis Dam - feet	60 X 180
Average channel depth - feet	25
Average channel width - feet	300
ACCESS ROADS	
Powerhouse access road (length to be constructed) - miles	0.78
Tailrace access road (length to be constructed) - miles	0.74

RELOCATION OF U.S. ROUTE 52	
Width of Pavement	24'
Shoulder Width	10'
Type Pavement	Asphaltic Concrete
Length of Relocation	2900'
Length of Bridge	713'
Width of Bridge	44' C to C
Clearance Above Water	16'
Horizontal Clearance, Center Span	40'
Type of Bridge	Prestressed Concrete
Number of Spans	11
RELOCATION OF S.C. ROUTE 8-45	
Width of Pavement	24'
Shoulder Width	10'
Type of Pavement	Asphaltic Concrete
Length of Relocation	4950'
Length of Bridge	784'
Width of Bridge	44' C to C
Clearance Above Water	16'
Horizontal Clearance, Center Span	40'
Type of Bridge	Prestressed Concrete
Number of Spans	11
RELOCATION OF S.C. ROAD 8-35	
Width Pavement	24'
Shoulder Width	8'
Type of Pavement	Asphaltic Concrete
Length of Relocation	2300'
Length of Bridge	604'
Width of Bridge	44' C to C
Clearance Above Water	16'
Horizontal Clearance, Center Span	40'
Type of Bridge	Prestressed Concrete
Number of Spans	9

UTILITIES

Power Line Crossings	Approx. Station Location	Approx. Vertical Clearances
115 Kv. 3 Phase	STA 147+00	EL. 123' MSL
115 Kv. 3 Phase	STA 501+00	EL. 75' MSL
230 Kv. 3 Phase	STA 501+00	EL. 77' MSL
34 Kv. 3 Phase, 4-wire	STA 146+50	EL. 121' MSL
12.4 Kv. 3 Phase, 4-wire	STA 194+30	EL. 121' MSL
7.2 Kv. 1 Phase	STA 307+00	EL. 112' MSL

Telephone Line Crossings	Approx. Station Location	Approx. Clearances
1 - 50 pr. - AWG 22 Cable	STA 194+30	On Bridge
1 - 200 pr. - AWG 24 Cable	STA 255+00	On Bridge
1 - 50 pr. - AWG 22 Cable 1 - 100 pr. - AWG 24 Cable 1 - 200 pr. - AWG 22 Cable 1 - 300 pr. - AWG 24 Cable 1 - 400 pr. - AWG 24 Cable 1 - CCTV Coaxial Cable	STA 309+00	On Bridge

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE AND SANTEE RIVER, SOUTH CAROLINA

FEATURE DESIGN MEMORANDUM

FISH HATCHERY

PREPARED BY

BUCHART-HORN
CONSULTING ENGINEERS and PLANNERS
WILLIAMSBURG, VIRGINIA

FOR

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

JULY 1980

INTRODUCTION

1. Authorization. The facility covered in this report comprises part of the Cooper River Rediversion Project, Lake Moultrie and Santee River, South Carolina. The Cooper River Rediversion Project, which will reduce shoaling and restore the historic saline regimen to Cooper River and Charleston Harbor, was authorized by the River and Harbor Act of 1968 (P.L. 90-483, 90th Congress, S. 3710, August 13, 1968). Section 101 of the 1968 Act is quoted in part as follows:

> "....That the following works of improvement of rivers and harbors and other waterways for navigation, flood control, and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and supervision of the Chief of Engineers, in accordance with the plans and subject to the conditions recommended by the Chief of Engineers in the respective reports hereinafter designated....Cooper River, Charleston Harbor, South Carolina: Senate Document Numbered 88, Ninetieth Congress, at an estimated cost of $35,381,000...."

2. Purpose. This memorandum presents information describing a proposed fish hatchery, including plans, costs, justification and design criteria. The proposed fish hatchery is of the same general design as the present hatchery at Moncks Corner with only minor modifications made, without betterment, in the floor plan and equipment, at the request of the South Carolina Wildlife and Marine Resources Department. This report is submitted for

approval of the proposed fish hatchery plan to serve as a basis for subsequent contract negotiations, detailed plans and specifications, and ultimate construction.

3. Scope. This memorandum provides a detailed design for the new fish hatchery which will replace the existing Moncks Corner fish hatchery. The following items are included:

a. Report of Necessity.

b. Criteria for Design and Specifications for use in preparing construction plans and specifications for the work recommended in this FDM.

c. Cost analysis and detailed drawings of the proposed fish hatchery building and related appurtenances and equipment for the operation of the hatchery.

d. The legal obligations of the United States Government are discussed in the agreement between the Corps of Engineers and the South Carolina Wildlife and Marine Resources Department, Appendix "A".

4. Locations. The proposed fish hatchery site is located approximately 1,000 feet north of the new power-house site and about one mile north of St. Stephen, South Carolina. Plate 1 shows the general location of the fish hatchery.

5. Owner's Opinion. The development of the proposed plan and arrangements for design and construction have been coordinated with South Carolina Wildlife and Marine Resources Department officials. The Department has been afforded the opportunity to review and comment on appropriate aspects of this memorandum which are pertinent to their interests in the plan. As a result of this coordination, the final plan as presented herein is essentially acceptable by the Department officials and no particular difficulty is anticipated in negotiating a corresponding agreement as shown in Appendix "A". Copies of recent pertinent correspondence with the Department are shown in Exhibits 1 thru 6.

b. Fish Hatchery. The Cooper River Rediversion Project requires the construction of a fish hatchery on the tailrace canal of the new powerplant to provide the capacity lost by the present hatchery. The capacity at the new hatchery is based upon: criteria established in cooperation with the South Carolina Wildlife and Marine Resources Department. The replacement facility is necessitated by the fact that only twenty per cent (20%) of the present river flow will be in Cooper River, after rediversion is completed, while eighty per cent (80%) will be returned to the Santee River. Between the two (2) hatcheries, continuous hatching operations, throughout the construction and rediversion period, can be accomplished. See Exhibits 1 thru 6.

DESCRIPTION OF FACILITIES AFFECTED

7. General. At present, the average flow of 15,600 cfs down Cooper River attracts anadromous fish which swim upstream each spring to spawn. After rediversion takes place and the fresh water release into Cooper River is reduced to an average of 3,000 cfs, migration of anadromous fish is expected to decrease considerably. This decrease will adversely affect the operation of the South Carolina Wildlife Resources Department fish hatchery now located on the tailrace canal of the Jefferies (Pinopolis) Hydro Plant. This hatchery is an important source of striped bass for lakes and streams all over the country.

8. Location. The existing fish hatchery is located on the tailrace canal of the Jefferies (Pinopolis) Hydro Plant which is located north of Moncks Corner in Berkeley County, South Carolina.

9. General Description. The existing Moncks Corner fish hatchery, operated by the South Carolina Wildlife and Marine Resources Department, consists of the following:

a. Two (2) brood fish holding tanks. One (1) tank is approximately 18' X 60' X 4', and the other is approximately 12' X 20' X 5'. Both are constructed of concrete blocks set on a concrete slab.

b. A building with two (2) hatching process rooms, kitchen, mechanical room, storage room, and laboratory. The overall building size is about 40' X 80' consisting of an original concrete block building with several wooden frame additions.

c. A boiler and a cooling unit with a capacity to heat or cool 150 gallons of process water per minute.

d. The water supply to the facility consists of three (3) wells, two (2) for process water and one (1) for domestic supply. System head on the process side is developed through an elevated storage tank 6' X 6' X 8', and booster pumps.

e. Paved Roadway.

f. Paved boat ramp and wooden floating dock.

g. Electric power is furnished by Santee Cooper on a distribution line whose estimated outage is six (6) times annually for approximately two (2) hours per outage.

SITE DEVELOPMENT

10. General. As shown on Plate 3, Site Plan, the site has been developed for the construction of a hatchery building with outdoor spawning area and three (3) brood fish holding tanks, and appurtenances, such as water supply wells, elevated water tank, driveways, parking lots, and an on-lot sanitary sewage system. An area of approximately 300 feet by 170 feet will be cleared for the site. Finish grade will be at elevation of 62.0 to match the upper patrol road elevations which vary from approximately elevation 62.0 to 65.8. An estimated 4,000 cubic yards of fill material will be required to grade the site as proposed. The borrow area shall be in the general project area close to the hatchery site. The building area and the parking lots will be protected by a six (6) foot non-climbable chainlink fence, topped with three strands of barbed wire. The entrance road, from the relocated County road to the north of the hatchery, will be designed by others. Access to the upper patrol road of the canal from the hatchery will be surfaced with asphaltic concrete pavement.

11. Real Estate. The Corps will provide to the State sufficient area for the hatchery through a perpetual easement within the project area including road right-of-ways for access to the site and to the tailrace canal. Reversion rights are retained by the Government should the State cease to operate the hatchery. A copy of the proposed agreement is included in Appendix "A".

12. Pavement. The parking area will be surfaced with four (4) inches of asphaltic concrete in two (2) equal layers on top of six (6) inches of crushed stone base course meeting South Carolina Department of Highway specifications. Weight of pavement is approximately 100 pounds per square yard per inch of depth.

13. Landscaping. Careful aesthetic analysis has been applied to the landscape planning. The area will be appropriately landscaped compatable with powerhouse areas and other adjacent features using lawns, shrubs, and trees. Evergreens, azaleas, and cotoneasters are selected for the planter in the front of the building, and deciduous azaleas and cotoneasters for the back planter. Other landscaping features include the following:

a. Oak trees at the entrance gate.

b. Dogwood trees around the boat parking lots.

c. Dogwood trees and viburnum at the north corner of the parking lot.

Details of the landscaping plan are shown on Plate 10.

14. Drainage. It is planned to discharge the surface water from the site and the wastewater from the hatchery to the side ditch along the canal berm. Sanitary wastewater will be collected separately into a septic tank and drainfield for disposal. Wastewater from the hatching process and brood fish holding tanks will contribute a maximum flow of three hundred (300) gallons per minute, or 0.67 cubic feet per second. This flow will not have any significant affect on the canal berm side ditch.

The site drainage facilities will be designed for a ten (10) year storm. The side ditch is V-shaped with 3 on 1 side slopes. Average channel velocity ranges between two (2) and three (3) feet per second. Erosion control will consist of grass and jute material in areas of higher velocity. Where slopes exceed three (3) percent, paving may be necessary.

Drainage facilities for the project are described in the following:

a. The hatchery site is planned to drain from northwest to southeast, corresponding to the original ground slope. With elevation 62.0 set for the building floor, the driveway will slope down from northwest to southeast at four-tenths per cent. The driveway will have a cross slope of three-eights (3/8) inch per foot. Storm water from the site will converge to a catch basin at the southeast corner of the sidewalk curb. A fifteen (15) inch pipe is designed to deliver the stormwater to the canal berm side ditch. The westerly ditch, along the respective entrance road, will be extended along the boat parking area to patrol road drainage ditch, and the easterly ditch will be extended along the car parking area around the drainfield to the patrol road drain ditch. One twenty four (24) inch culvert with end sections, is provided along the center line of the canal berm side ditch, crossing under the hatchery site entrances.

b. In the hatching room and laboratory, a six (6) inch open floor drain underneath each hatching table will be used to drain wastewater. Their depth will vary from six (6) to twelve (12) inches to provide a minimum slope of four-tenths per cent. The drains will be covered with grating to keep out trash and protect employees. The wastewater in the drains will then be discharged through a six (6) inch pipe to the area drainage system.

c. A six (6) inch pipe will be extended from the catch basin to the drain pipe of the elevated water tank. Wastewater from the brood fish holding tanks will also discharge into the six (6) inch pipe. Underneath the spawning table, another catch basin is proposed for the floor drain and receiving wastewater from the spawning process. The water supply lines will also be connected to the drain system with control valves, as appropriate, to enable the operators to completely drain the supply system when not in use. Roof water will be collected through the perforated pipe and discharged into the site drainage system.

15. Fish Handling Operations. Fish to be used for the hatchery operations will be collected in the Intirace Canal adjacent to the new hatchery and placed in a portable tank carried within the boat used to collect the fish. This tank will then be hoisted from the collector boat at the fish lift facility to the level of the levee patrol road and placed in a truck for hauling to the hatchery. The portable tank will be a part of this project whereas the electrically operated hoisting crane and boat launching ramp will be provided in the Powerhouse Contract.

HATCHERY BUILDING

16. [illegible] has been made to be aesthetically simple and quiet. The architectural design for the hatchery is compatible with the neighborhood and surrounding area. Architectural plans are shown on Plates [illegible], [illegible], and [illegible].

17. [illegible]

a. Materials have been selected for ease of maintenance, suitability for function, and aesthetic pleasure to the viewer.

b. [illegible]

c. [illegible]. All other [illegible] will be [illegible].

d. All [illegible]

e. [illegible]

f. All exposed wood trim will be redwood or western red cedar.

g. Kitchen, toilets, and lab spaces will have plasterboard ceilings with insulation over the ceilings. No other areas will have ceilings.

18. Heating, Cooling, and Ventilation. Kitchen, toilets, and laboratory spaces will be heated and cooled with a heat pump. The hatching room will have electric unit heaters and mechanical ventilation.

19. Equipment. The following equipment will be provided for the operation of the hatchery:

a. Hatching Room - shelves, packing table, tool cabinet; five

tables (3' x 18' x 3'), two hundred (200) hatching jars, and twenty five (25) aquaria (thirty (30) gallon capacity); two (2) air blowers, and supplemental eductors for supplemental oxygen in the process water.

b. Kitchen - hot water heater, double sink, cabinets, 12.0 cubic foot refrigerator, and thirty (30) inch range.

c. Laboratory - laboratory cabinets, double sink; two (2) tables (3' x 8' x 3'), twenty-four (24) hatching jars, and four (4) aquaria (thirty (30) gallon capacity); heater and chiller to heat or cool water ten (10) degrees F at twenty four (24) liters per minute, with temperature thermostatically controlled to within ± 0.5°F; a stable shelf for analytical balance; oxygen-temperature monitor with alarm set.

d. Others - twenty-five (25) cubic feet freezer used for producing ice for shipping [illegible].

e. In accordance with the requirements of the Basic Plumbing Code [illegible], Section [illegible] (Code Administrators) two (2) bathrooms [illegible] being furnished, one (1) for each sex. Paragraph P-1302.2 of the code states in part "in other than residential installations, separate facilities shall be installed for each sex".

STRUCTURAL DESIGN CRITERIA AND STRUCTURES

20. General. This section presents the structures and the design criteria, loads, stresses, assumptions and notations that will be used in preparing the structural design of the fish hatchery facilities.

21. Criteria. All design will be based on accepted engineering practices.

a. EM 1110-1-2101 "Working Stresses for Structural Design".

b. EEL 1110-2-105 "Details of Steel Reinforcement for cast-in-place concrete".

c. Other applicable manuals in the EM 1110 series.

22. Assumed Material Weights.

Material	Unit Weight, lbs/cu. ft.
Water	62.5
Concrete	150
Steel	490

23. Dead Loads. Calculated weight of structure and appurtenances.

24. Live Loads.

a. Water Pressure - Triangular distribution of the static water pressure acting normal to the face of the structures.

b. Wind Load - 30 lbs/sq. ft. in accordance with "The BOCA Basic Building Code, 1978" seventh edition for 130 MPH wind velocity.

c. The site of the structure is in seismic zone # 3.

d. Lateral loads to be distributed according to relative stiffness of members. Cavity walls may be designed independently or lateral forces may be transferred through bracing at the ceiling wall-plate to other perpendicular walls.

25. Earth Bearing Pressure. Earth bearing pressure assumed to be 1,500 pounds per square foot. Footings to bear on compacted gravel or on undisturbed earth having a minimum allowable bearing capacity of 1,500 lbs. per square foot.

26. Basic Design Stresses. The structural components will be designed in accordance with the BOCA Building Code, 1978, and recommendations of applicable Engineering Manuals for Civil Works Construction. Design stresses are in accordance with EM 1110-1-2101, "Working Stresses for Structural Design". Applicable stresses are as follows:

a. Structural Steel - Basic Working Stress 22,000 psi bending.

b. Concrete - Use 3,000 psi concrete

27. Elevated Water Tank. Preliminary design of the elevated water tank in shown in Appendix "B". Structural design computations are described in the following:

a. The water tank will be twelve (12) feet by twelve (12) feet square and eight (8) feet deep. The tank will be elevated to twenty-five (25) feet above the finished grade line on a support tower. The wind load, in accordance with EM CA Code (1978) for one hundred thirty (130) miles per hour velocity, was applied at the corner of the tank to allow the largest surface exposure. This condition, with the tank full of water produced the greatest stress in one support leg.

b. The tank was assumed to have water at a depth of eight (8) feet for the greatest loading condition. There will be two (2) overflow controls, one (1) at the normal water depth of six (6) feet, and another one (1) at water depth of seven (7) feet. Should both the overflows malfunction the water depth could reach eight (8) feet.

c. The soil conditions at the site of the water tank are not known. boring T-71 (S Approximately four hundred fifty (450) feet to the south it. The footings were designed on the basis of an assumed allowed bearing of one thousand five hundred (1,500) pounds per square foot. The smallest reaction on the footings is without water, which the worst case uplift condition. The uplift dictated the required footing weight.

d. The Corps will provide a test boring to determine actual design bearing stress at the tank site.

28. Spawning Area. Spawning area will have a table and fish holding tanks. The area will be surfaced with six (6) inch concrete pavement. The pavement will be placed on four (4) inches of gravel. Finished grade will be elevated 0.9 to match the building floor. The surface will be sloped to a catch basin underneath the spawning table for drainage.

29. Holding Tanks. Holding tanks will include two (2) tanks for brood fish, (Capacity - twenty (20) females and forty (40) males) and one (1) tank for stripped brood fish as shown on Plate 6 and described in the following:

a. Each of the two (2) brood fish holding tanks will be forty (40) feet long, six (6) feet wide, and four (4) feet deep. Water depth will be three (3) feet. The top of the tanks will extend three (3) feet above grade. Tank floors will slope three (3) inches toward the exit end for drainage. Each tank will be individually connected to the water supply and drainage system. Slots in the tank walls will be provided for baffles and screen dividers. Baffles will be used for water depth control and screen dividers for brood fish separation.

b. The tank for stripped brood fish will be twenty-two (22) feet long, five (5) feet wide, and four (4) feet deep. Water depth will be three (3) feet. The top of the tank will extend three (3) feet above the grade. Tank floor will slope two (2) inches toward the exit end for drainage. Slots in the tank walls will also be provided for baffles and screen dividers.

WATER SUPPLY

30. Water Demand. Total water demand for the project is estimated at three hundred (300) gallons per minute as shown in Appendix "C", Hydraulic Computations, Sheet No. 1. The water demand includes the following water uses:

a. Hatching Process - Striped bass eggs are hatched in modified McDonald hatching jars. Water is fed through a plastic tube into the bottom of the jar, and currents thus created keep the eggs in constant motion. Dead eggs become buoyant and are discharged from the top when operated at optimum flow rate, approximately one (1) liter per minute. There will be two hundred (200) jars provided in the hatchhouse and twenty (20) jars in the isolaters for the total of 220 jars. Therefore, a total water flow of two hundred twenty (220) liters per minute or sixty (60) gallons per minute will be required.

b. Brood Fish Holding Tank - Two (2) tanks will be provided for holding brood fish in reserve. With an average water depth of three (3) feet, the total water volume of the two (2) tanks is 1,766 cubic feet. A water flow of 1,766 cubic feet per hour, or its equivalent of 220 gallons per minute is required if the tank water is completely changed every hour - one turnover per hour. However, one third of this will be supplied from recirculation. According to the water use of the South Carolina Wildlife and Marine Resources Department, a minimum water flow of fifty (50) gallons per minute is required (see Exhibit I). Total water demand for the brood fish holding tanks will be two hundred twenty (220) gallons per minute.

c. Domestic Water Use - Domestic water use consist of water uses for kitchen, restroom, and showers. It is estimated at twenty (20) gallons per minute of water flow for the total domestic water use.

31. Water Quality Requirements.

a. South Carolina Wildlife and Marine Resources Department has set the water quality requirements for the hatching process water. The requirements are:

Temperature	60 to 68° F
P.H.	7.5 to 8.5
Alkalinity (total)	140 to 200 Mg/L
Total Hardness	110 to 200 Mg/L
Ca Hardness	60 to 100 Mg/L

CO_2	7 Mg/L (max.)
Turbidity	.05 J.U. (max.)
Iron	1.0 Mg/L (max.)
Copper	.01 Mg/L (max.)
Total Dissolved Solids	300 Mg/L (max.)

b. In addition to the above requirements, constant water temperature is required for the laboratory. A device which is capable of heating or cooling water ten (10^{0}) degrees F at twenty (20) liters per minute, with temperature thermostatically controlled to within $\pm$ 0.5^{0}F, will be provided.

c. The Corps is currently conducting a testing program on the water discharged from the powerhouse dewatering wells in order to ascertain the quality thereof. Water quality in these wells should be representative of that to be expected from the new wells. If the quality meets or is less than the minimum requirements stated above, no treatment facilities will be necessary.

d. Process water is not taken from the tailrace canal principly due to the existing turbidity therein. Excessive turbidity is detrimental to the hatching process and would require extensive treatment facilities. Excessive turbidity in the holding tanks makes it difficult to locate the brood fish and increases the chances of injuries during handling which is also extremely detrimental to the overall hatching process.

32. Ground Water Hydrology. Ground water hydrology of the area is presented in "THE EFFECT OF THE COOPER RIVER REDIVERSION CANAL ON THE GROUND-WATER REGIMEN OF THE ST. STEPHEN AREA, SOUTH CAROLINA" prepared by U.S. Geological Survey, Water Resources Division, Columbia, South Carolina, October, 1975.

a. Based on the aquifer characteristics from the powerhouse test on Aquifer 2 and the leaky aquifer equation, drawdowns were determined assuming a three hundred (300) gallons per minute pumping rate for sixty (60) days. Values of computed drawdown for various radii were shown in Appendix "C", Hydraulic Computations, Sheet No. 2, and summarized as following:

Radius (Feet)	Drawdown (Feet)
750	65.7
1,000	55.6
2,000	40.5
3,000	27.3

b. Detailed chemical analyses of water samples from selected wells were conducted by the Survey's laboratory and shown in the following table. The water quality in general meets the requirements of the South Carolina Wildlife and Marine Resources Department. The constituents of carbon dioxide and copper were not included in the analyses, but should be performed in the future well test.

c. Well water is a dependable supply of good quality with minimum temperature fluctuation. Use of well water diminishes the probability of encountering trash and turbidity, either of which can completely disrupt hatching operations. Normally a test well would be drilled to establish the reliability of an underground source of supply, however, due to the current dewatering program at the site of the proposed hatchery, a test program at the hatchery would not provide accurate information. Design of the supply wells will be based on information contained in Design Memorandum No. 6 - Site Selection and Geology (Ground Water Section), as it relates to the underground water supply and on chemical test of water currently being pumped at the power house site. The transmissibility, permeability and storage coefficient coefficients to be used will give the quantity and effect of pumping. It will also provide the information necessary for the final location and number of operation wells.

33. Well Construction. The construction details are based on the data presented in the "Report on the Ground Water Resources of Berkeley County, South Carolina". In order to get these needed gallons per minute of water flow, an eight (8) inch well pump with a 40 HP motor will be required. To the drilling cost is the price per foot of the actual well. The constructed approximate depth of the well is two hundred (200) feet. The well is to be set at the hatchery. At a pumping rate of three hundred (300) gallons per minute for forty-eight (48) hours, the drawdown in the operating well is estimated to be one hundred nineteen (119) feet. To assure sufficient water withdrawal without excessive drawdown, the well is to be constructed to withdraw water from both Aquifers 1 and 2.

34. Well Pumps. Eight (8) inch submersible well pumps rated at three hundred (300) gallons per minute each have been selected for the project. The total dynamic head from the pump setting to the top of the storage water tank is estimated at one hundred seventy-five (175) feet. Each pump shall have a twenty-five (25) horsepower motor, operating on three (3) phase, sixty (60) hertz power at three thousand five hundred (3,500) RPM. A separate well pump capable of pumping twenty (20) gallons per minute will be supplied for the domestic supply.

35. Elevated Water Tank. Sufficient storage capacity to provide a two (2) hour operational reserve for the hatching process is a minimum requirement for emergencies as set forth by the South Carolina Wildlife and Marine Resources Department. A twelve (12) feet square by eight (8) feet high

TABLE FROM U.S. GEOLOGICAL SURVEY

--Chemical analyses of water from observation wells.

Well No.	Aquifer	Date of sample collection	Silica (SiO_2)	Iron (Fe) (Total)	Aluminum	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity (as $CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (Sum)	Residue solids	Hardness as $CaCO_3$	Specific conductance a/	pH b/
7	1	5/1/73	35	.560	.040	33	1.9	7.7	1.5	118	97	1.0	6.0	0.2	0.0	150	148	90	211	7.2
9	1	5/15/73	22	.010	.010	30	1.3	3.6	1.3	94	77	0.8	6.0	0.5	0.8	110	115	80	180	7.2
11	1	5/3/73	21	.050	030	32	1.7	3.8	2.5	105	86	1.2	5.0	0.2	1.0	120	131	87	209	7.7
21	1	6/7/73	37	.030	.060	50	2.6	14	4.0	178	146	5.2	12.0	0.3	1.6	210	214	140	350	7.4
4	2	5/16/73	30	.020	.070	24	7.8	11	8.0	153	126	4.0	5.0	0.3	0.0	160	165	92	229	7.7
8	2	4/30/73	30	.070	.100	40	1.3	3.9	1.7	125	103	2.8	5.0	0.2	0.0	150	147	100	270	7.3
10	2	5/25/73	27	.700	.040	53	1.7	4.6	2.0	171	139	1.6	8.0	0.2	0.0	180	180	140	288	7.5
12	2	5/3/73	28	.010	.010	66	3.0	9.6	4.2	23	194	0.4	10.0	0.5	0.0	230	240	180	380	7.4
20	2	4/16/73	25	-	-	56	2.1	7.2	2.6	192	157	0.8	8.0	0.1	0.0	190	197	150	320	7.7
22	2	6/6/73	35	.020	.050	50	4.0	20	9.0	222	182	2.8	8.0	0.3	0.1	230	234	92	360	7.7
14	3	6/4/73	25	2.2	.020	20	2.8	9.4	2.3	74	61	2.4	12.0	0.2	0.0	120	114	62	170	6.7

Note.--Results in milligrams per liter except specific conductance

a/ Micromhos at 25°C

b/ Units

water storage tank is, therefore, designed to fulfill this requirement. An approximate six (6) feet depth of water will provide a two (2) hour operational emergency reserve for the hatching process at sixty (60) gallons per minute. To provide sufficient head to the fill lines which feed individual jars, the tank will be set with its bottom twenty-five (25) feet above grade. A spray system will be provided at the intake line for oxygenation of water. Designs of spray nozzles are shown on Appendix "C", Hydraulic Computations, Sheet No. 3. An alarm system to warn of water failure and D.O. deficiency will also be provided. Overflow piping will deliver water to the brood fish holding tanks. This overflow will be set to maintain six (6) feet of water storage. A second overflow pipe will be set at eight (8) feet to provide an emergency overflow to drain. The water supply line to the hatching room will be set at six (6) inches above the tank bottom to exclude sand and a drain pipe set at the tank bottom. Tank insulation, a tank cover with insect screen around the open area, and an access ladder for access to tank will also be provided. Details of the elevated water tank are shown on Plate 9.

WATER DISTRIBUTION

36. Piping For Hatchery Process. With sixty (60) gallons per minute design flow, a four (4) inch pipe is selected to deliver water from the elevated tank to two (2) inch feeder lines in the hatching room. Two (2) inch feeder lines are to be installed on top of each hatching table to feed water through one-fourth (1/4) inch plastic fill lines to each individual jar. The plastic fill lines are flexible and easy to move from jar to aquarium or vice versa. As shown on Calculation Sheet No. 4 (Appendix "C") Hydraulic Calculations, the total head loss from water tank to the fill line is only three (3) feet. The elevated water tank will provide twenty (20) feet of static head above the fill line. Therefore, neither booster pumps nor pressure regulators are required. Process water piping is shown on Plate 8. Accessories provided on the system will include the following:

a. A pet cock on each fill line for flow control.

b. A blow-off valve at the end of each feeder line for pipe cleaning.

c. A drain pipe with a gate valve at the lowest elevation of the four (4) inch line for line drainage during shutdown.

d. An eductor on the six (6) inch line for oxygen booster to maintain a dissolved oxygen content of approximately six (6) part per million.

e. A water chiller and a hot water heater with a capacity to heat or cool water ten (10°) degrees F at twenty-four (24) liter per minute for laboratory use. Temperature thermostatically controlled to within ± 0.5°F.

37. Piping For Brood Fish Holding Tanks. A six (6) inch feeder line is designed to supply water from the elevated tank through four (4) inch lines to each of the holding tanks. Water will be withdrawn through the overflow pipe set at six (6) feet to prevent interference with water supply and storage for the hatching process during an emergency. A plug valve will be provided on each of the four (4) inch lines to control water flow to the holding tanks.

38. Piping For Domestic Uses. To avoid affecting the hatching process water supply, a separate two (2) inch supply line has been furnished for domestic service. As shown in detail on Plate 8, piping is so arranged to supply water to kitchen, bathrooms, hose bibs in the hatching room, and yard hydrants in the spawning area. A pressure regulated system with a one hundred twenty (120) gallon pressure tank will be included to provide the operating water pressure. The system, including fixtures, has been designed for water conservation.

SANITARY SEWAGE DISPOSAL SYSTEM

39. Regulations. Regulation 61-56, Individual Waste Disposal Systems Regulations and Standards by South Carolina Department of Health and Environmental Control are used for the design of the sanitary sewage disposal system. The local approving agency is: Environmental Health Division, Berkeley County Health Department, 109 West Main Street, Moncks Corner, South Carolina 29461. An application for on-site disposal of sanitary wastes will be filed by the Corps, with the State agency in order that an approvable system can be provided as part of the final design.

40. Estimated Sewage Flow. The fish hatchery provides a kitchen and two (2) rest rooms for a maximum of twenty-four (24) employees a day. Based on a water consumption of fifty (50) gallons per person per day, the sewage flow is estimated at one thousand two hundred (1,200) gallons per day. The fish hatchery will be operated only six (6) to eight (8) weeks a year during the fish spawning season (April - May).

41. Septic Tank. According to the regulations, minimum capacities of septic tanks for an estimated flow less than one thousand five hundred (1,500) gallons per day shall be one and one half (1½) times daily flow. With an estimated flow of one thousand two hundred (1,200) gallons per day, the septic tank shall have a minimum liquid capacity of one thousand eight hundred (1,800) gallons. With four (4) feet liquid depth and twelve (12) feet by five (5) feet and four (4) inches surface area, the septic tank provides one thousand nine hundred (1,900) gallons of liquid volume. Details of the septic tank, based on Standards for Septic Tank Design and Construction, are shown on Plate 9.

42. Soils Report. The soils report will be prepared by the County Department upon receipt of an application and location information from the Corps. Their report will provide the final design parameters for the system.

43. Final Disposal System. Conventional absorption trenches are proposed for use in the disposal system. Design of the distribution pipes and absorption trenches will be based on the requirements set forth in the regulations. The required number, length, and configuration of conventional absorption trenches shall be determined by the design engineer in conformance with the regulations of the local health authority and shall be based upon the number of persons using the facilities, percolation tests, and soil conditions.

ELECTRICAL

44. General. The basis of design covers, in general, Electrical Systems Design for New Fish Hatchery Building in St. Stephen, South Carolina, including lighting, control and power distribution to provide complete and usable electrical systems for this facility.

45. Reference Criteria.

a. National Fire Protection Association (NFPA) standards.

b. Latest edition of Illuminating Engineering Society Lighting Handbook.

c. Underwriters' Laboratories, Inc. (UL) Standards.

46. Service and Service Equipment. Secondary service equipment is to be used. Service characteristics to be 120/208V - 3Ø - 4W, from a 500KW power company transformer.

47. Panelboards, Metering, and Voltage Drop.

a. Panelboards will be of the circuit breaker type. Branch breakers will have minimum twenty (20) ampere trip rating and a minimum interrupting rating of ten thousand (10,000) RMS amperes symmetrical.

b. Power company metering will be provided. The power company is the Berkeley Electric Coop Inc.

c. In lighting or combination lighting and power loads, the combined voltage drop on feeders and branch circuits will not exceed five (5) per cent. Approximately two (2) per cent will be apportioned to feeders and three (3) per cent to branch circuits. A maximum voltage drop of ten (10) per cent will be allowed on motors during starting.

48. Circuits, and Wiring Method.

a. Branch circuits will be minimum No. #12 AWG copper conductors, type THHN-THWN.

b. One spare circuit, rated two thousand two hundred (2,200) volt amperes will be provided for each five (5) active circuits in each panelboard.

c. Wiring systems will be installed in accordance with National Electrical Code 1978 Edition.

d. Generally, motors of one-half (1/2) horsepower or less will be connected to one hundred twenty (120) volt single phase circuits.

e. Motors over one-half (½) horsepower will be connected to two hundred eight (208) volt, three (3) phase circuits.

49. Lighting Intensities, and Lighting Fixtures.

a. Intensities for interior fixtures will be:

Batching Area	25 F.C.
Laboratory	100 F.C.
Kitchen	100 F.C.
Mechanical Room	30 F.C.
Toilet Rooms	30 F.C.
Storage	10 F.C.

b. Interior lighting fixtures will be:

Kitchen Area - Fluorescent, 2X 4 - 4 lamp troffer, acrylic, prismatic lens.

Laboratory, Batching Room and Mechanical Room - Incandescent, industrial, P.L.M. Door with lamp guard.
NOTE: 4' fluorescent lamps are to be 35 watt energy saving type.

Toilet Rooms - 1' x 1' recessed incandescent fixture with flat lens.

c. Lighting intensities for exterior fixtures will be:

Parking Area	5.0 F.C.
Roadway	1.5 F.C.
Ponds	1.0 F.C.

d. Exterior fixtures shall be high pressure sodium in various types of distribution chosen for the particular area to be lighted. All exterior luminaires will be automatically controlled by the use of photo cells.

50. Communication System and Grounding.

a. The design will cover conduit, and fishwire from telephone backboard to all outlets. The design will not include wiring and components at the backboard.

b. Grounding shall be in compliance with National Electrical Code.

c. Ground conductor will be provided to all panelboards and equipment.

51. Installation and Equipment Standard. Installation of all equipment shall conform to the applicable rules of the National Electrical Code. All applicable materials and equipment shall bear the label of the Underwriter's Laboratory.

52. Energy Conservation. Energy saving fluorescent lamps (40 watt) will be used in lieu of standard 60 watt lamps.

53. Emergency Power Source. Because of the nature of the product being produced at this aquaculture hatchery, and because of the location of this site in relationship to the substation, i.e., at the end of the feeder, a reliable emergency power source is extremely important in preventing a loss of fish in the event of an outage of the commercial power source.

The Power Company estimates the average yearly power outage history for this site would be two (2) times per year with each outage being a minimum of two (2) hours.

Based on the estimate of outages provided by the Power Company, and the critical nature of a continued supply of water to the hatching room, a two (2) % ac water pump has been provided in the elevated tank and an emergency generator connection has been provided in the electrical system.

ESTIMATED COST

54. Summary Project Cost Estimate.

COOPER RIVER REDIVERSION PROJECT
FISH HATCHERY

Summary Project Cost Estimate
(April 1980 Price Levels)

Cost Account No.	Item or Feature		Current Cost Estimate
06.	Fish Hatchery		$363,300
30.	Engineering and Design (11%)		$ 39,800
31.	Supervision and Administration (8.0%)		$ 29,064
		Sub Total	$432,164
		Contingencies (10%)	$ 36,330
		Total Cost	$468,494
		Use	$469,000

55. Comparison With The Latest Approved Pb-3 Estimate. A comparison between the latest Pb-4 estimate prepared in June 1980 yields a price increase of $69,000. This overall increase is due to a more precise estimate and the addition of security fencing at a cost of $40,000 including E&D, S&A and contingencies. This fence was not included in the original estimate because the existing hatchery is within a secure area at the Jeffries Steam Plant. The new hatchery will be in an isolated area. The balance of the rest of the price increase is due to the more detailed design presented in this DM relative to the GDM plan.

56. Detailed Cost Estimate

DESCRIPTION	QUANTITY	UNIT	PRICE	TOTAL
Site:				
Landscape	1	Lump Sum	$ 7,100	$
Borrow Fill	4,100	CY	14,350	
Fence - Security Type	800	LF	30,400	
Culverts	95	LF	2,500	
Paving & Sidewalk	1	Lump Sum	18,900	
Parking Bumpers & Painting	1	Lump Sum	2,935	
Trees & Shrubs	1	Lump Sum	3,000	79,185
Domestic Waste:				
Septic Tank & Distribution Box	1	Lump Sum	3,609	
Piping	730	LF	2,923	
Trench, Agg., Sand	1	Lump Sum	6,568	13,100
Electrical	1	Lump Sum		61,780
Architectural: (7,312 SF)				
Concrete & Excavation	1	Lump Sum	15,188	
Doors	1	Lump Sum	2,899	
Masonry Walls & Partitions	1	Lump Sum	7,423	
Lumber, Roof Truss, etc.	1	Lump Sum	23,466	
Gravel Drain	125	LF	550	
Planter	125	LF	9,700	
Insulation	1	Lump Sum	6,165	65,391
Holding Tanks & Spawning Table:				
Concrete & Excavation	1	Lump Sum	9,000	
Wood Baffles	300	EA	900	
Screens	27	EA	8,100	
Drain Valves	3	EA	500	
Movable Grating	3	EA	300	
Table	1	EA	800	19,600
Page Total				239,056

Estimate Summary
Page 2

Hatchery Equipment:

Hatching Jars & Aquariums	1	Lot	19,000	
Piping Hoses, Valves, etc.	1	Lot	18,500	
Tables	7	EA	500	
D.O. Monitor	1	EA	1,000	
Cabinets, Sinks, Shelves, etc	1	Lot	3,174	
Oxygen bottles	2	EA	300	
Blowers	2	EA	7,800	
Tool Cabinet	1	Lump Sum	600	50,874

Miscellaneous:

Toilets	1	Lump Sum	500	
Shelving	1	Lump Sum	300	
25 CF Freezer & Refrig.	1	Lump Sum	1,500	
Cabinets, Sinks, Pumps	1	Lump Sum	1,200	
Air Conditioning	1	Lump Sum	4,500	8,000

Outdoor Piping:

Potable Water	1	Lot	12,200	
Drains	1	Lot	17,400	
Water Tank	1	EA	8,000	
Wells	2	EA	27,800	65,400

Page Total	124,274
Page 1 Total	239,056
Grand Total	$363,330

CONCLUSIONS AND RECOMMENDATIONS

57. Operation And Maintenance. All operation and maintenace of the completed facility, including utilities, grounds buildings, boat ramp, approaches and parking area will be done by the SCWMRD at no cost to the Government.

58. Conclusions.

a. This memorandum is in accord with minimum feature DM requirements listed in letter by SACEN-GP, dated 12 October 1979. The proposed project plan has been developed within the guidelines of ER 1180-1-1 to provide substitute facilities which will compensate the South Carolina Wildlife and Marine Resources Department for detrimental project effects to their facilities. The plan is substantially the same as stated in the GDM.

b. The capacity of the proposed project plan is based upon criteria developed in association with the South Carolina Wildlife and Marine Resources Department.

c. The plan is estimated to cost Four Hundred Sixty-Nine Thousand Dollars ($469,000.00) which would compensate for adverse effects to the existing hatchery. The proposed plan has been developed in appropriate coordination with the Owner and the overall project plan.

d. It is planned that the construction of the relocated hatchery be completed and ready for operation prior to rediversion.

e. The Owner is essentially in agreement with the proposed project plan.

All construction and design work would be at the expense of the Government. No betterments are involved in the proposed plan.

59. Recommendation. It is recommended that the proposed plan and attendant information presented in this memorandum be approved as a basis for this office to proceed with the design of final contract plans and specifications for the hatchery.

EXHIBITS

SAMGE 13 October 1972

Mr. Jefferson C. Fuller, Jr.
Chief, Game & Fish Management
S. C. Wildlife & Marine Resources Dept.
P. O. Box 167
Columbia, South Carolina 29202

Dear Mr. Fuller:

This is in response to your letter of 22 September requesting guidance as to the type of information the State might furnish to further justify building a striped bass hatchery during initial construction of the Cooper Rediversion Project.

In our general design report to higher authority, we proposed early construction of a new hatchery on the Santee River similar to your existing Cooper River facility. Our attempt to define the needs for the new hatchery was mostly in general terms, considering an approximate post-project flow reduction in the Cooper River of about 80 percent. We also included in the report, a copy of Mr. Webb's letter of 8 March 1971 which gave State views on the matter. However, after considering our proposal, the Chief of Engineers has requested additional justification supporting the new hatchery construction. Specifically, I am directed to submit information giving sound reasons in response to two questions. (1) Why construction of the new hatchery is required prior to the determination is made that the fish run has actually moved from the Cooper to the Santee River, and (2) why the existing hatchery cannot be used even though the fish run does move from the Cooper to the Santee River?

In order to further substantiate the need for construction of a new hatchery during initial project construction, it is imperative that I receive information from your Department to constructively answer these two questions. I would suggest that as much of the information as possible be detailed in statistical form and derived or projected from reasonable factual data.

EXHIBIT 1

SAYGE

13 October 1972

Mr. Jefferson C. Fuller, Jr.

Webb's letter contained some comparative statistics on fish life in the Cooper based on the low-flow period during the Pinnopolis fire in early 1970. If data is available, your similar analysis of any other periods of significant flow changes in the Cooper River would be helpful. However, these determinations only help to point up the magnitude of the project impact. What is lacking in our justification is suitable information to conclusively establish that post project fish life conditions in both rivers and corresponding hatchery procedures will relatively change enough to warrant a new hatchery on the Santee as an obligation attributable to the project. Unless this information is furnished in convincing detail, the Corps will be obliged to consider that determinations of the need for a new hatchery should be based on examination of prototype conditions as recommended by the U. S. Fish and Wildlife Service in their report. Such an arrangement would permit greater assurance of an equitable solution to this matter. While time would be required to examine the prototype and perform any indicated remedial work, we do not believe such an interim period would, in itself, critically affect fish life or hatchery activities. It should be borne in mind that the project is considered reversible to permit corrective measures, should any unexpected severe effects develop.

On 25 and 26 October, a meeting is scheduled in the Savannah District Office to discuss and perhaps resolve comments from higher authority on the general design report. Representatives of the Chief of Engineers, the Division Engineer, the Savannah District Engineer, and my office will attend. During this meeting, I would be pleased to convey any additional information concerning this matter that time permits you to furnish me.

Sincerely,

ROBERT C. NELSON
Colonel, Corps of Engineers
District Engineer

South Carolina
WILDLIFE AND MARINE RESOURCES DEPARTMENT
POST OFFICE BOX 167 COLUMBIA, SOUTH CAROLINA 29202

JAMES W. WEBB, Executive Director

AT RYAN
DIRECTOR, DIVISION
OF GAME AND
FRESHWATER FISHERIES

JEFFERSON C. FULLER, JR.
CHIEF, GAME AND
FISH MANAGEMENT

October 25, 1972

Colonel Robert C. Nelson
District Engineer
Charleston District, Corps of Engineers
P. O. Box 919
Charleston, South Carolina

Dear Colonel Nelson:

At the September meeting of the S. C. Water Resources Commission you indicated that additional justification is needed for constructing the striped bass hatchery as part of the proposed Cooper River Rediversion Project. On October 14, 1972 you provided me with a letter outlining the information needed for justification.

I have conferred with Fisheries Biologists Curtis, Whitt and Boyle concerning this matter, plus reviewing our prior reports and correspondence pertinent to this matter. I submit the following factual information for your consideration.

It will be impractical and inefficient to transport adult brood fish from Santee River to the existing hatchery because of losses from excessive handling and transportation. Adult striped bass, especially gravid females, are extremely sensitive to any form of handling. This fact was emphasized repeatedly in the 1966 and 1967 hatchery reports and subsequent annual progress reports. Excessive losses were also experienced by North Carolina personnel when brood fish were transported long distances to the Fayetteville Hatchery for subsequent induced spawning.

In our experience, at least 40 percent mortality has resulted in adults when it was necessary to transport them from Santee River. This is in spite of our best efforts to save the fish, including the use of sea salt, quinaldine, potassium permanganate and acriflavin. In addition, those fish which do survive are weakened to the point that the eggs obtained are of poor quality. Our records here indicate an average hatch of 45 percent of eggs obtained from Cooper River fish; the mean hatch of eggs from fish transported from Santee River was 20 percent.

EXHIBIT 2

When the capability of Santee River to produce sufficient brood fish to support our hatchery operation is examined, the situation again is to be bleak. In 1970, due to a reduced water flow in Cooper River and a resulting paucity of fish there, it was necessary to expend at least half of our collection effort in Santee River. However, only about 5 percent of that year's fry production resulted from Santee River fish and it is improbable that Santee River fish could have produced significantly more fry than they did that year. As you know, Wilson's sanctuary is a small area, where collection efforts are fairly effective in terms of the percent of available fish which can be collected. There were, simply, not many more fish there that were collected. Tagging studies, reported in the annual progress report of 1970, provided further evidence of the small size of the Santee River population, as compared with that of Cooper River.

These studies also indicated that no movement of striped bass occurred [illegible]. Given this information, it is critical [illegible] Santee River population to be strengthened by Cooper River fish following rediversion.

One further point concerning transportation of brood fish is that we have been able to return adult fish to Cooper River following spawning. This is due to allowing a portion of the fish to return to Cooper again. Although we have been unable to evaluate the success of this procedure, there is little doubt that additional handling and transportation of striped bass which have been subjected to the stresses of induced artificial spawning will reduce their chances for survival when they are returned to Santee River.

Regarding the other question, of why we need the new hatchery operational at the time the flows are reduced in Cooper River, we have already submitted considerable evidence. In addition to this, we offer the following "reasonable factual data".

First, we submit the record of fry obtained from 1968 through 1971 along with the mean daily discharge from the Pinopolis Hydroelectric Plant during February and March as obtained from the South Carolina Public Service Authority. February and March flows are used because this is the period during which striped bass are migrating to the spawning grounds, this migration being largely guided by the attraction flow of the river.

Year	Average Volume of Flow			Fry Produced
	Feb.	March	Feb. and March	
1969	19,649	12,790	16,431	102,7[illegible]
1970	21,280	22,[illegible]	21,764	104,[illegible]
1971	11,171	4,957	8,[illegible]4	54,[illegible]
1971	28,556	28,[illegible]	28,[illegible]	102,6[illegible]

These data fully indicate that the control of flow in Cooper River will not [illegible] availability of brood fish, which in turn will prevent [illegible] to this [illegible] we are still experimenting at the [illegible] which [illegible] the [illegible] the [illegible] rate [illegible] attract [illegible] depletion [illegible] when the [illegible] probably fall to [illegible] the striped bass eggs to sink to the bottom and suffocate. In our professional opinion, the rediversion project will eventually result in almost a total loss of striped bass in Cooper River except for the few fish which migrate from Lake Moultrie.

As previously stated, the striped bass population in Santee River at present is [illegible] estimated at [illegible] which are conservatively estimated at [illegible]. We expect depend upon straying which find their way to Pinopolis Tailrace and the few fish we will be able to collect and transport from Santee River to meet these needs.

We have looked into the economic impact of the situation since the Corps likes to deal in dollars. Future striped bass operations will undoubtedly be exclusively directed toward fingerling-rearing. At present, reports received from the Striped Bass Committee of the Southern Division of the American Fisheries Society show that an average of 10 percent of the fry received are successfully reared to fingerlings (three inches). Undoubtedly this percent will increase as research improves rearing techniques, but to be conservative we will use current figures.

The Pollution Committee of the Southeastern Division of the American Fisheries Society has placed monetary values on striped bass by inch class. Using the Pollution Committee's figures, a three-inch striped bass is worth 7½ cents. Again, these figures are conservative; the state of Florida has placed a value of $10.00 each on a striped bass regardless of size.

Given that each fingerling stripped bass is worth $.75 and that ten percent of the fry we produce [illegible], our annual [illegible] at a [illegible]% [illegible] has to date been worth $[illegible]. If our fry production is increased by only [illegible] percent, [illegible] of a $500,000.00 hatchery, the annual [illegible] will be $1,[illegible].

One additional consideration, which strays from the purpose of this letter, is of greater impact than any of the above items. That is that, once the new hatchery is operational at the [illegible] reservoir, there is a world of water only depleted [illegible] we must immediately exploit it for fry production. [illegible] would raise the population to [illegible], under proper reservoir conditions, to a level which will satisfy [illegible] sport fishermen. In addition to [illegible], we feel that [illegible] striped bass per year, [illegible], in Santee River. The cost of such stocking [illegible] by the Corps of Engineers.

Currently we have under construction at Bonneau Beach (Lake Moultrie) a striped bass rearing and research facility. This facility will require an outlay of over one million dollars. The successful operation of this facility is entirely dependent upon an uninterrupted source of striped bass fry year after year after year. We have established striped bass fisheries and hybrid fisheries in all of the major reservoirs of South Carolina. These fisheries are dependent upon annual stockings of striped bass and/or hybrids for every reservoir except Lake Marion and Lake Moultrie.

I hope you are sufficiently informed as to the value of striped bass to the Santee-Cooper area, as to their value to the State of South Carolina, as to their value to numerous other States and as to their value to the federal government. We have made numerous efforts by letters, reports and meetings to stress this importance and clarify the matter for your personnel.

I would appreciate an immediate reply from you concerning this matter since it is of so vital importance to our future plans and to the hunters and fishermen of South Carolina.

Yours truly,

[illegible]
Chief, Game and Fish Management

JCF,jr/jb

cc: Pat Fyall
Ed Bradley
Jack Hayles
Tom Carter
Miller White

BUCHART-HORN

CONSULTING ENGINEERS and PLANNERS
A VIRGINIA [illegible]

[illegible]
WILLIAM [illegible]

4 February 1980

Department of the Army
Charleston District
Corps of Engineers
P. O. Box 919
Charleston, South Carolina 29402

Attention: Mr. [illegible]

Reference: [illegible]
Contract [illegible]
Contract No. [illegible]
Project No. [illegible]

Gentlemen:

It was indeed a pleasure to [illegible] at the South Carolina Department of Wildlife & Marine Resources to review the requirements of the project, as well as to visit the existing and the site of the new one.

Included herewith is a [illegible] at the various data we discussed. You may wish to carefully review these to see if all of the items requested should be listed.

It should be noted, also, that a Draft Progress Chart was delivered for your review and [illegible].

If you have any comments and/or corrections that you feel should be made to the notes enclosed, please advise.

Again, my thanks for your time and guidance on the site.

Very truly yours,

BUCHART-HORN, INC.

Henry Gerhart, II, P.E.
Office Manager

HG/ml
Enclosures

EXHIBIT 3

COOPER RIVER REDIVERSION PROJECT

BERKELEY COUNTY, SOUTH CAROLINA

FISH HATCHERY DESIGN

MEETING AT SOUTH CAROLINA WILDLIFE & MARINE RESOURCES DEPARTMENT FOR REVIEW OF PRELIMINARY PLANS FOR PROPOSED FISH HATCHERY AT COOPER RIVER REDIVERSION CANAL & POWER HOUSE:

THOSE IN ATTENDANCE:

Corps of Engineers	- Mr. Lincoln Blake
S. C. Wildlife & Marine Resources Dept.	- Mr. Jack Bayless Mr. Reeple Harrel
Beckart Horn, Inc.	- Mr. Henry Gerhart

[illegible] PLANS GENERALLY AS FOLLOWS:

A. Due to lack of area and to cut construction costs, the engineer, Mr. Blake, stated that a pool storage should be provided for a minimum of three (3) hours - size 5' wide x 5' - with trucks to be able to provide water for two (2) hours during refilling.

B. A security fence should close new site to unauthorized, whereas present site is within secure area of Santee Cooper Power Company.

C. Rest rooms - toilets should have two (2) - there are female employees in the Department.

D. "Elevated Tanks" - on sketch plan should be an "Elevated Tank".

E. Mr. Harrel noted that laboratory shown on plan is essentially a "small hatchery room" with a controlled environment.

F. Water Supply -

1. Temperature - 60 - 68 degrees F - need full insulation
2. ph 7.5 - 8.5
3. Oxygen - saturated
4. Iron content - probably can be as high as 1 p.p.m., instead of .01 p.p.m. as noted in previous correspondence.
5. Water supply to brood fish can be discontinued during power emergencies, but not to hatching room.

G. Facility layout can be changed to fit conditions - may be able to improve work space.

Tanks are needed as follows:

1. One for stripped fish
2. One for approximately 40 lucks - unsegregated
3. One for females - 20 - each segregated

H. Department would like roof over tankage

I. Parking area should anticipate:

1. Visitors - say school bus, 10 cars,
2. Employees - say 8 to 10
3. Shipping trucks - pickups or small stakebodies - no tractor trailers

J. Present facility has heating/cooling system for water supply. Mr. Barkley indicates that it is not required in new facility except for laboratory supply.

K. Existing power supply appears to be single source, 3 phase.

L. Lighting in hatching room is to be incandescent - fluorescent may be detrimental to hatch.

M. Proposed Hatchery site, although somewhat disturbed by construction operations will not be materially changed by the Powerhouse Contractor.

N. Direct access to the new Hatchery is to be from a relocated County Road now under design by your Savannah office. We assume we should allow for an entrance to accomodate this access road in the site plan, and your office will design the connecting road itself.

Respectfully submitted,

Henry Gerhart, II, P.E.
Office Manager
Buchart-Horn, Inc.

HG/ml
2-4-80

BUCHART-HORN

CONSULTING ENGINEERS and PLANNERS
A VIRGINIA CORPORATION

8 February 1980

Department of the Army
Charleston District
Corps of Engineers
Post Office Box 919
Charleston, South Carolina 29402

Attention: Mr. Lincoln Blake

References: Fish Hatchery Design - Phase I
Cooper River Rediversion Project
Contract Letter [illegible]
Project Number [illegible]

Dear Sir:

Included herewith you will find sketches of three alternatives we made of the holding tank layout. Please review these and let us know your preference in at at a week.

A copy of this letter and the sketches are also being forwarded to Mr. Bayless of the South Carolina Department of Wildlife and Marine Resources for his review and comments.

If you have any comments on the holding tank layouts, please advise.

Very truly yours,

Henry Gerfort, II, P.E.

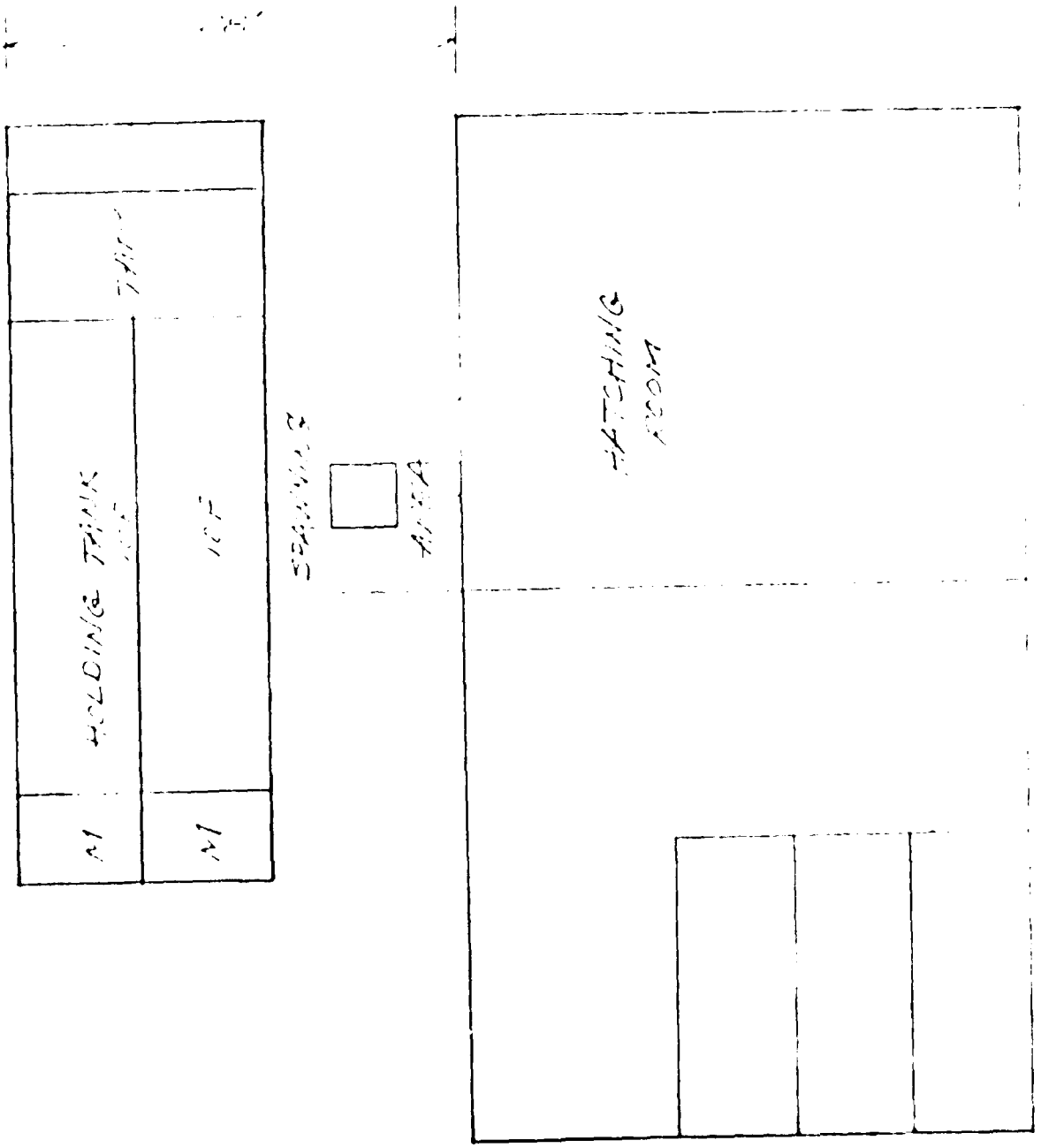
HCH/cfs

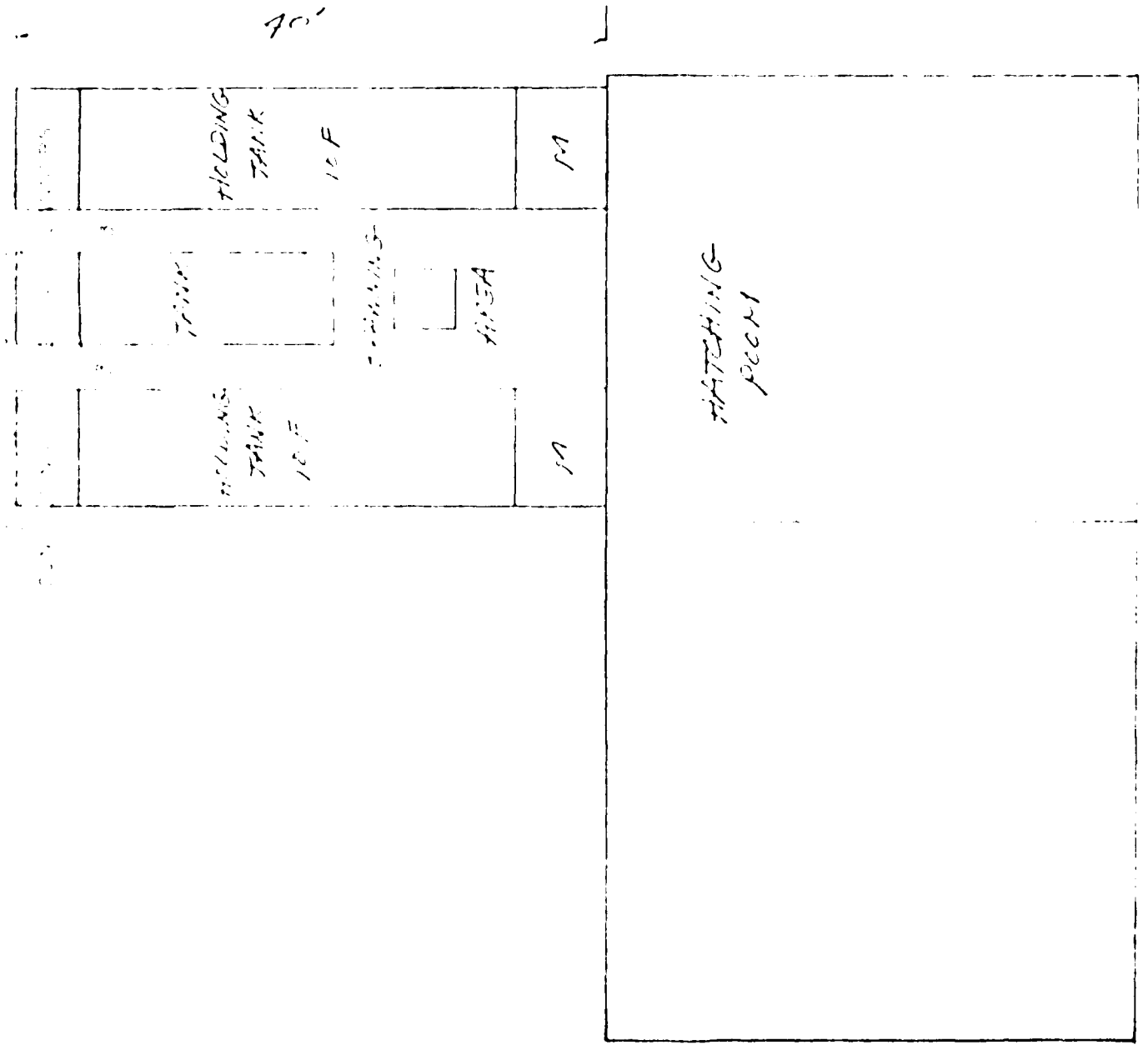
Enclosure

cc: Mr. Jack P. Bayless

EXHIBIT 4

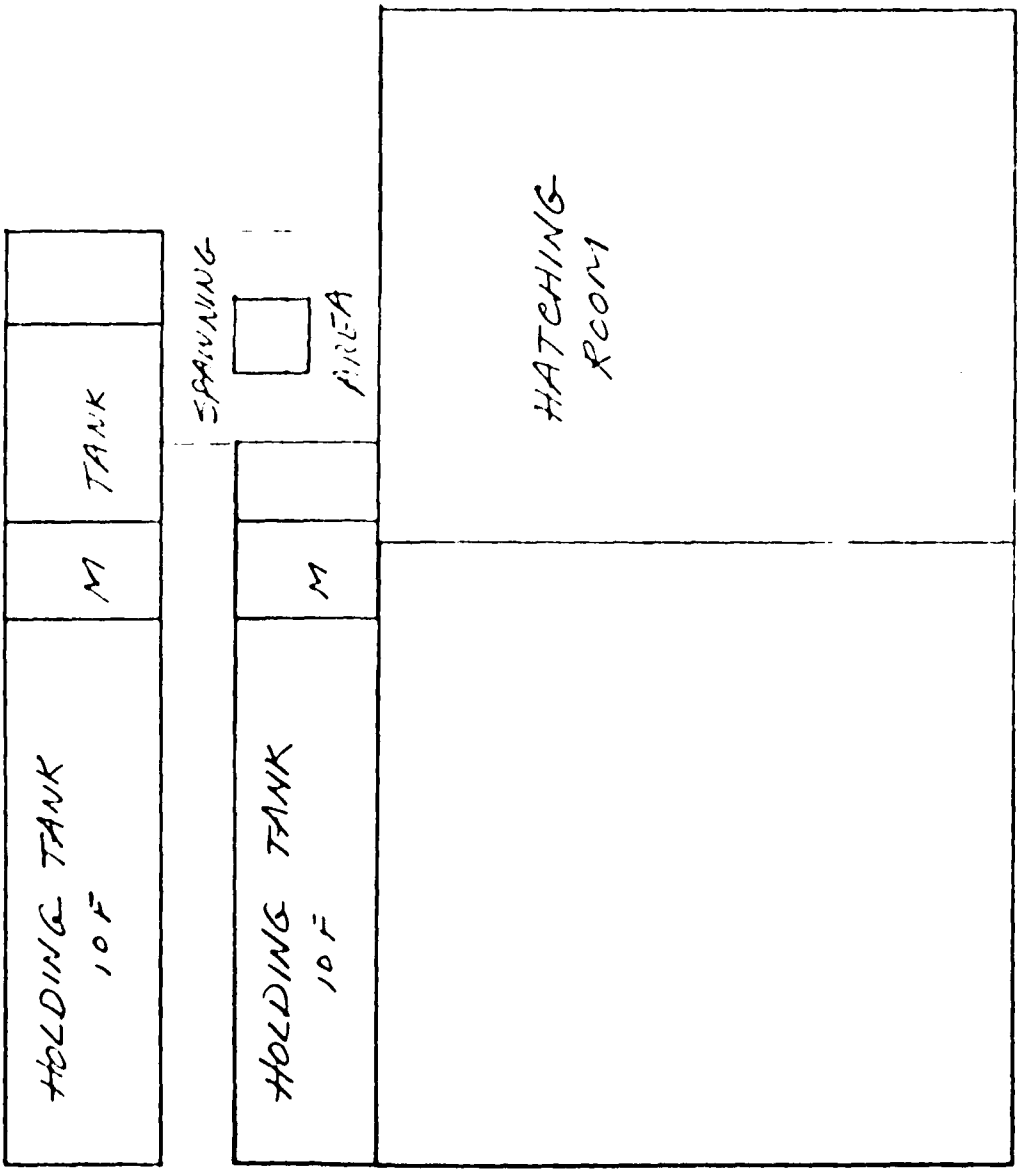
BY TCY DATE 2-7-80 SUBJECT C.C.E. - S.C. SHEET NO. 1 OF
CHECKED BY DATE FISH HATCHERY WORK UNIT 10
LAYOUT PLAN ALT. NO. 1




40'
BUILDING
TRAILER
10 F
M
M
TRAILER
BUILDING
TRAILER
10 F
BUILDING
TRAILER
10 F
M
M
TRAILER
PARKING
AREA
TRAILER
PARKING
AREA

BY JCY DATE 2-7 80 SUBJECT C.O.E. - S.C. SHEET NO 3 OF ...
CHKD BY ... DATE ... FISH HATCHERY JOB NO 80116-10
LAYOUT PLAN - ALT. NO. 3

EUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS



South Carolina
Wildlife & Marine
Resources Department

James A. Timmerman, Jr.
Executive Director
Jefferson C. Boyce
Director of
Wildlife and Freshwater Fisheries

February 13, 1980

Mr. Henry Gerhart, II
Buchart - Horn
Consulting Engineers and Planners
Busch Corporate Center
203 Packets Court
Williamsburg, Virginia 23185

Dear Mr. Gerhart:

Attached please find copies of your suggested layout plan. We prefer alternate number 2 and have made some suggestions on the drawing which we feel will help the overall setup.

If you have any questions, please call.

Sincerely,

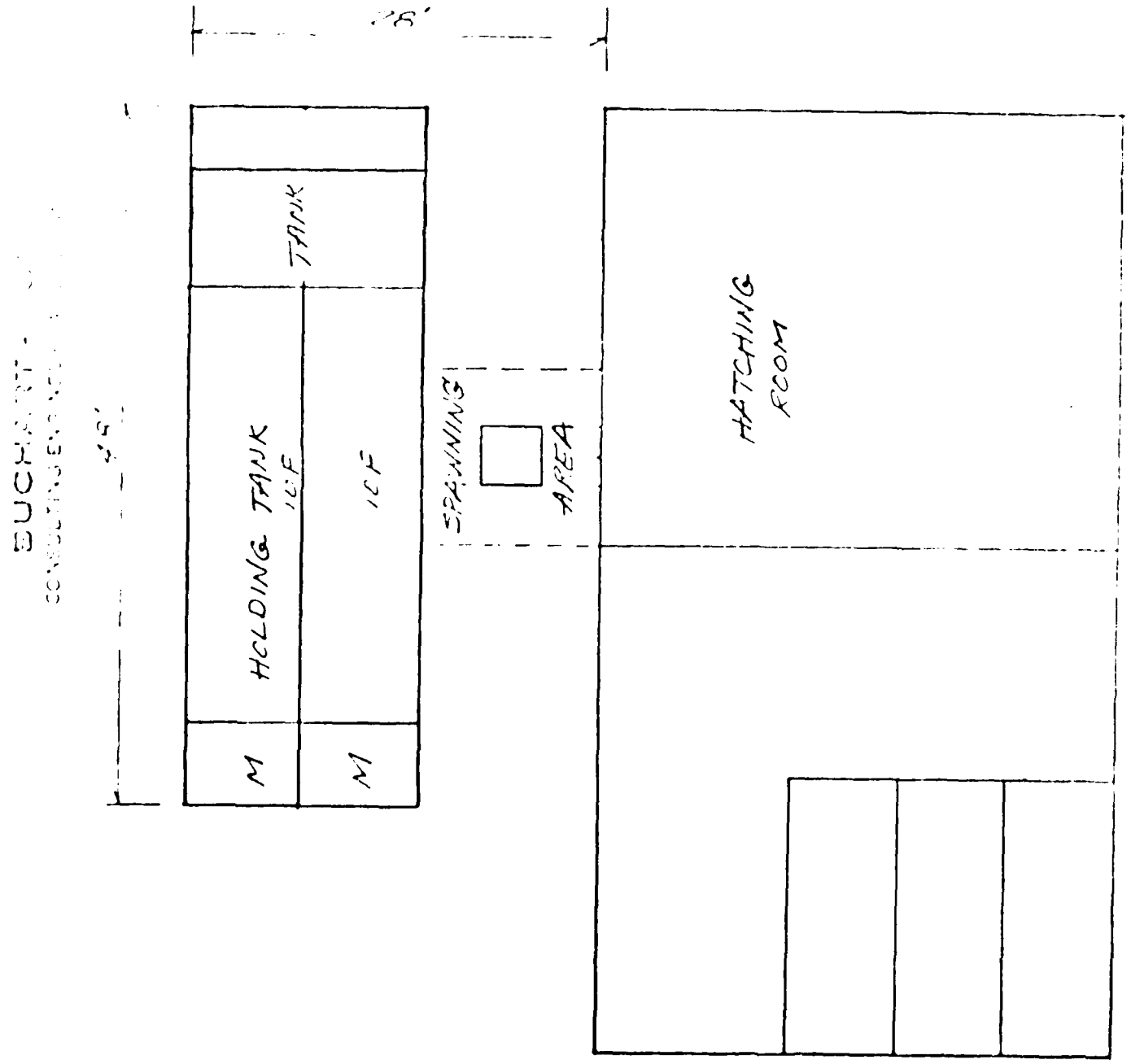
Jack D. Bayless, Chief
Dennis Wildlife Center

JDB:ew
cc:
Mr. Lincoln Blake

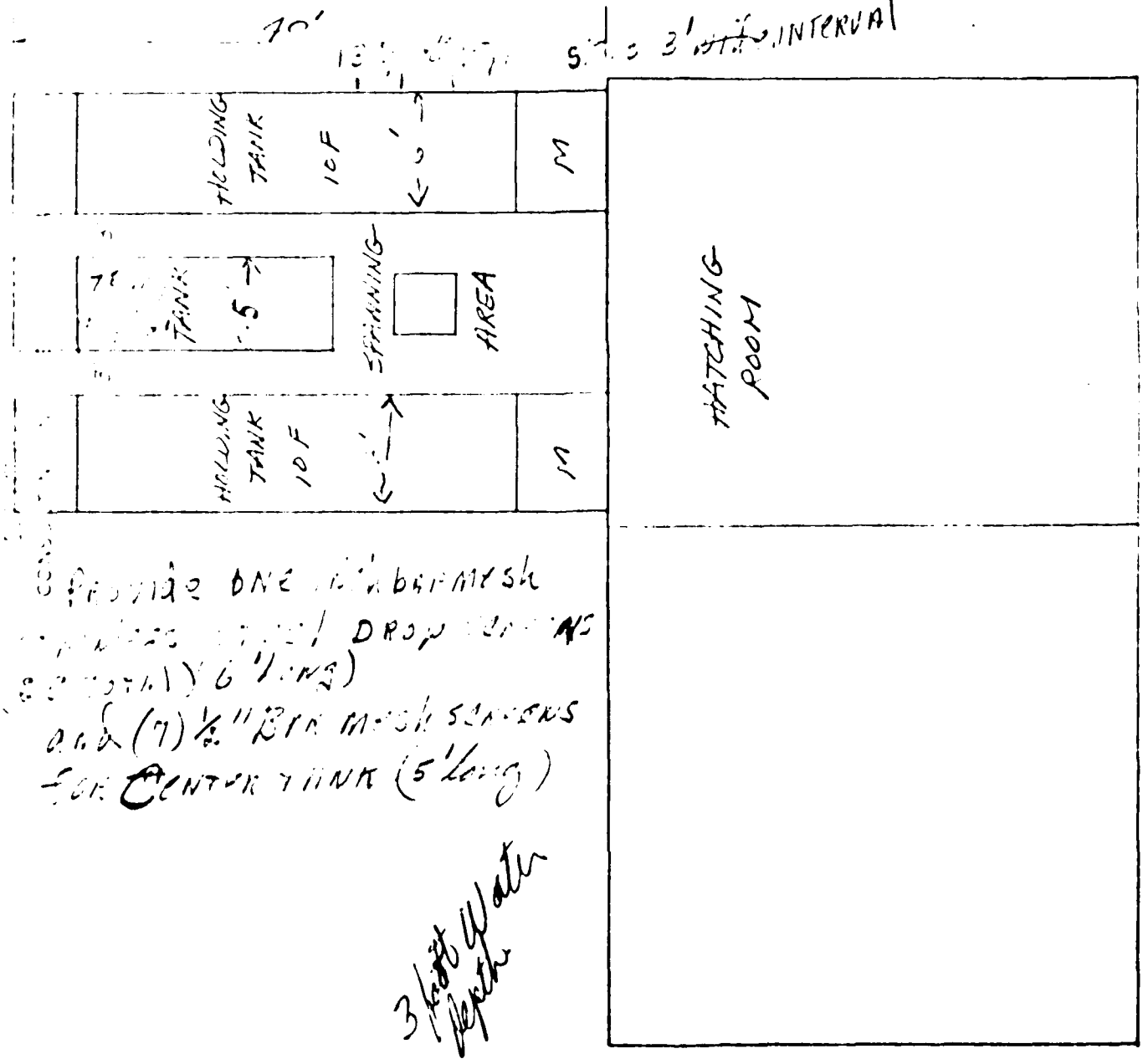
EXHIBIT 5

P O Drawer 170 ( ) Bonneau, South Carolina 29431 ( ) Telephone (803) 825-3387

BY TCY DATE 2-80 SUBJECT C.C.E.-S.C. SHEET NO. 1 OF
CHKD BY DATE FISH HATCHERY JOB NO. 7611C-10
LAYOUT PLAN - ALT. NO. 1



BY JCY DATE 2-7-80 SUBJECT C.O.E. - S.C. SHEET NO 2 OF ____
CHKD BY ____ DATE ____ FISH HATCHERY JOB NO 90116-10
LAYOUT PLAN - ALT. NO. 2



PROVIDE ONE (1) BRANCH WITH DROP (OR RISERS ESSENTIALLY 6' LONG)
AND (7) ½" BRASS MESH SCREENS FOR CENTER TANK (5' Long)

3 foot Water depth

BY TCY DATE 2-7-90 SUBJECT C.C.E. - S.C. SHEET NO 3 OF
CHKD BY ... DATE ... FISH HATCHERY JOB NO 9016-10
LAYOUT PLAN - ALT NO. 3

EUCHANT - POTTS
CONSULTING ENGINEERS AND PLANNERS

90116 10

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
P.O. BOX 919
CHARLESTON, SOUTH CAROLINA 29402

SACEN-G

7 March 1980

Mr. Henry Gerhart, II, P.E.
Buchart-Horn
203 Packets Court
Busch Corporate Center
Williamsburg, VA 23185

Dear Mr. Gerhart:

Reference is made to your 4 February letter addressing the Fish Hatchery Design. I met with Mr. Jack Bayless, SC Marine & Wildlife Resources Dept., on 29 February to review the comments that were made in the attachment to your letter. The following points are to clarify the understanding of both the Corps and the Department as to the design and these comments should be incorporated into the design.

a. No separate boat storage shed will be provided as part of this project. The large storage areas that are in the building will be as shown in the preliminary drawings, and are for the storage of boat motors, hatchery equipment, etc.

b. Concur.

c. One rest room will be provided.

d. Concur.

e. Concur.

f. Concur. The iron content shall not exceed 1.0 p.p.m.

g. Concur.

h. No roof shall be provided over the tanks as part of this project. The Department may elect to construct this roof later, so allowances should be made in the layout for this later addition.

i. Parking is to be provided for 10 employees only. No visitor parking is to be provided as it is not present at the existing site. Pavement or a finished surface should be provided within the security fence for boat storage.

j. Concur.

k. Concur.

EXHIBIT 6

SACEN-G 7 March 1980

Mr. Henry Gerhart, II, P.E.

l. Concur.

m. Concur.

n. Concur.

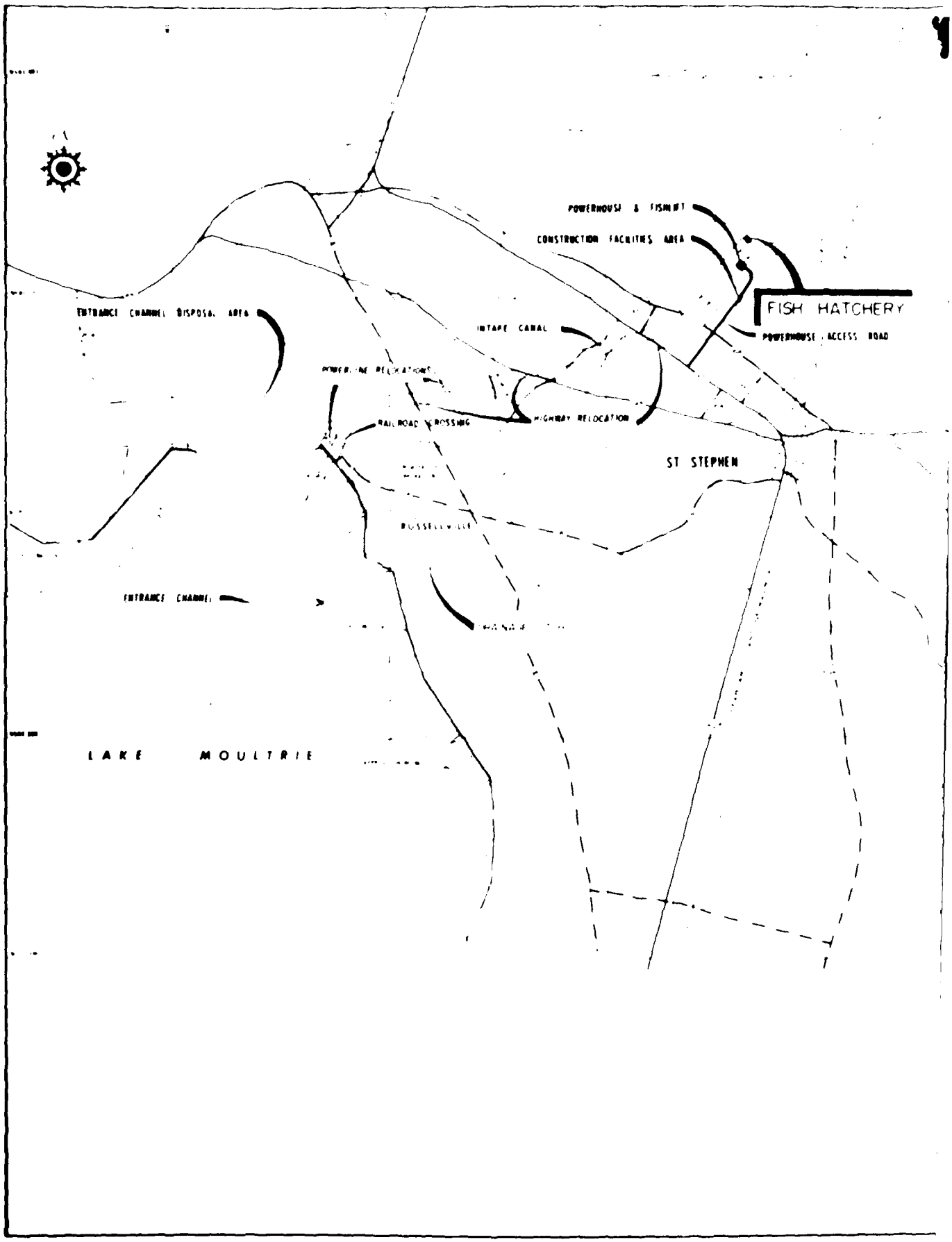
If you have any questions concerning the above please contact me.

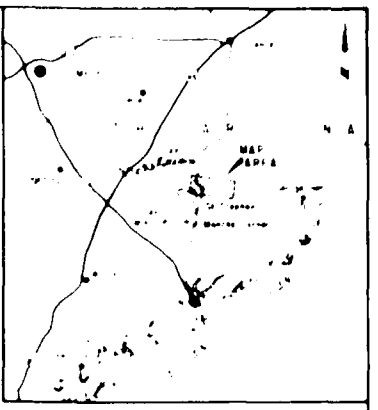
Sincerely,

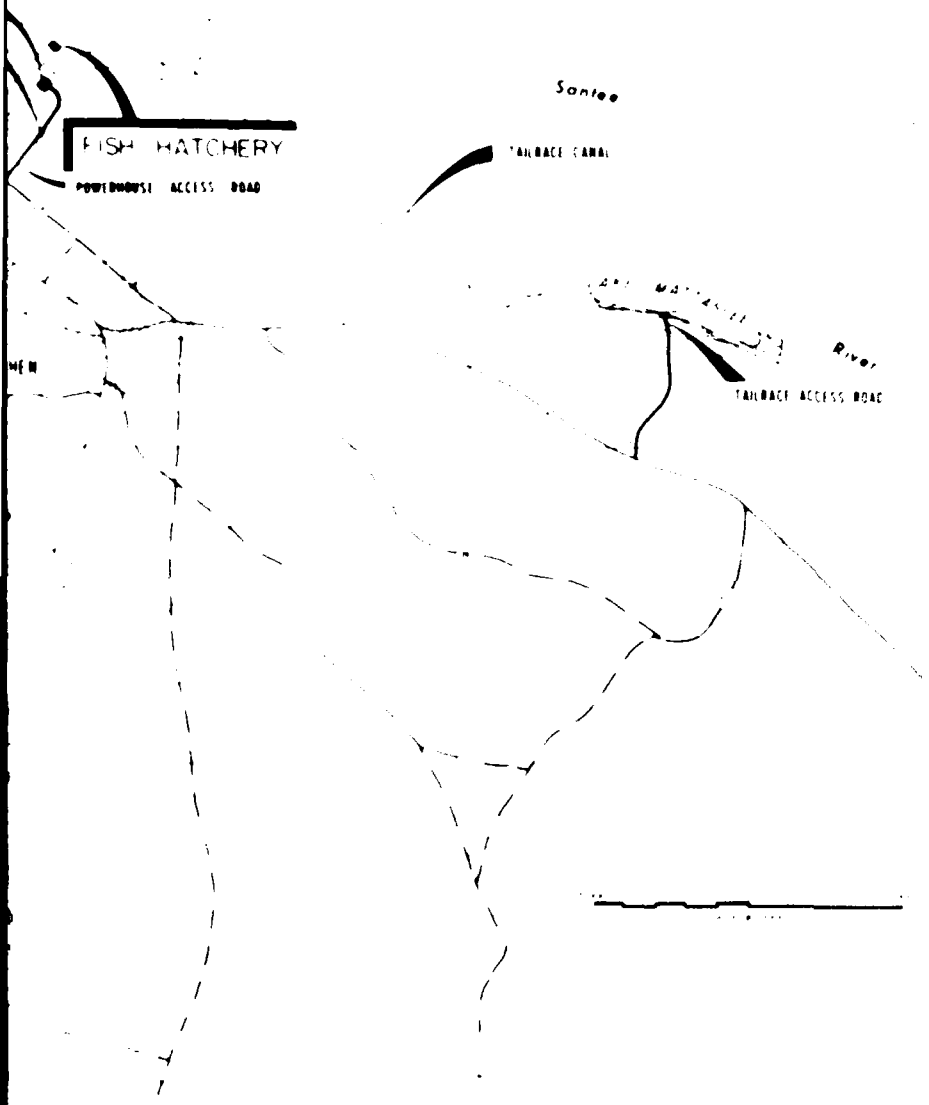
GEORGE H. FRANKLIN, JR.
Contracting Officer Representative

copy furnished:
Mr. Jack Bayless
SC Wildlife & Marine Resources Dept.
Bonneau, SC

PLATES


POWERHOUSE & FISHLIFT
CONSTRUCTION FACILITIES AREA
FISH HATCHERY
POWERHOUSE ACCESS ROAD
ENTRANCE CHANNEL DISPOSAL AREA
INTAKE CANAL
POWERLINE RELOCATIONS
RAILROAD CROSSING
HIGHWAY RELOCATION
ST STEPHEN
RUSSELLVILLE
ENTRANCE CHANNEL
LAKE MOULTRIE





LEGEND

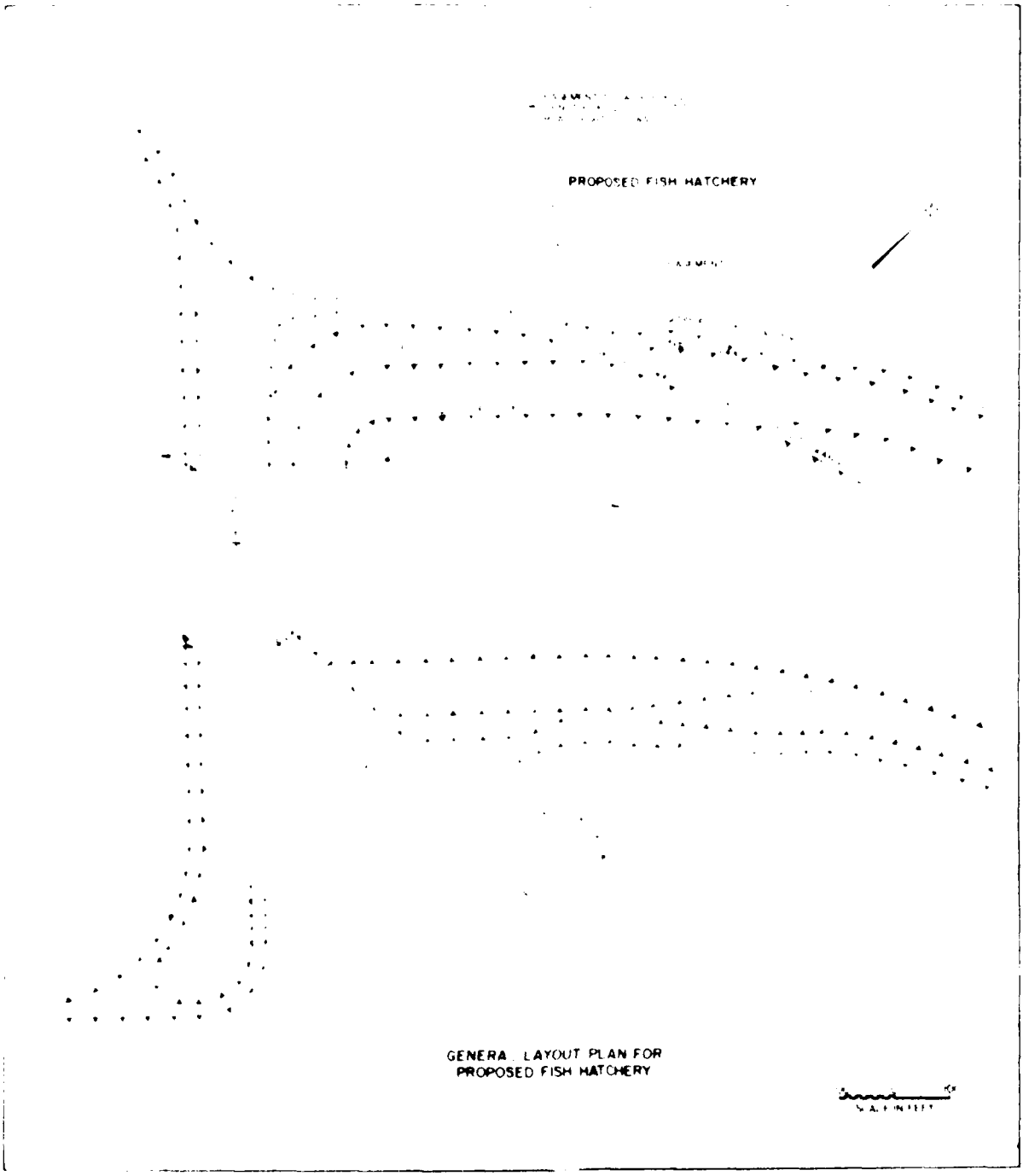
- U.S. HIGHWAY PRIMARY
- STATE HIGHWAY PRIMARY
- STATE HIGHWAY SECONDARY
- POWER TRANSMISSION LINE
- IMPROVED LIGHT DUTY ROAD
- UNIMPROVED DIRT ROAD & TRAIL
- STREAM
- LAND SUBJECT TO INUNDATION

FISH HATCHERY

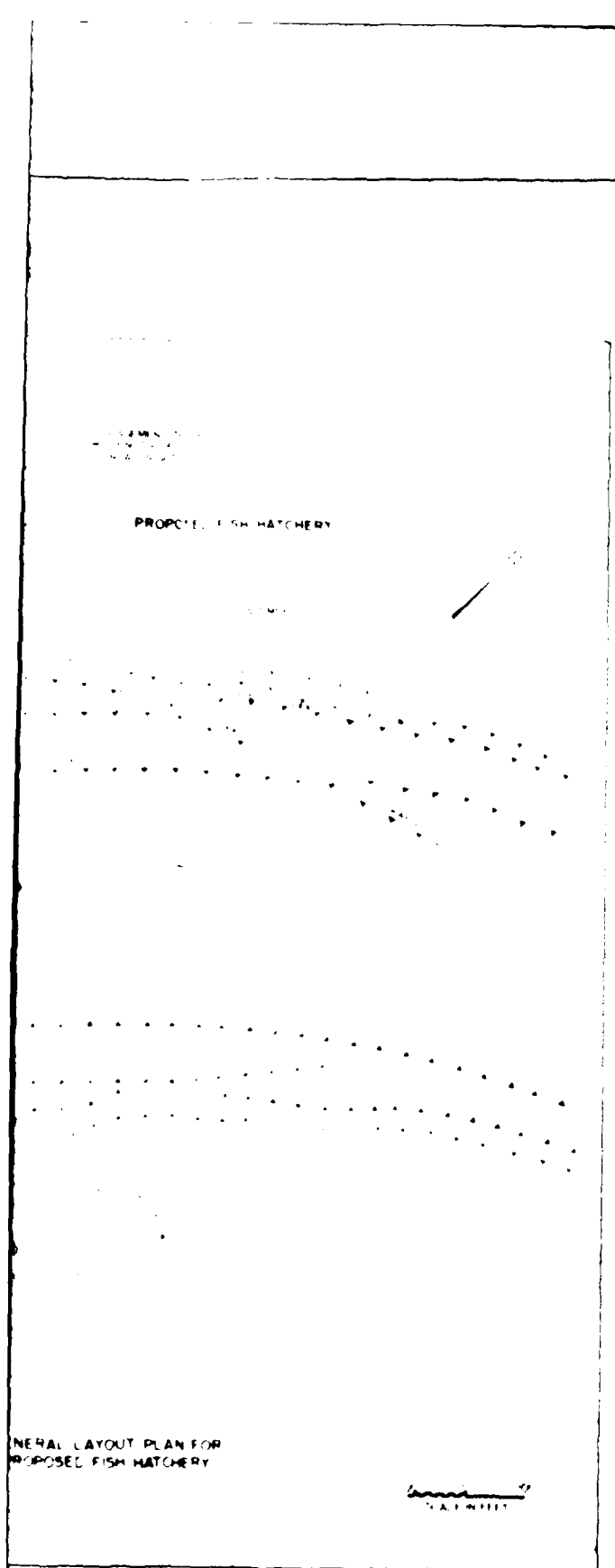
LOCATION PLAN

COOPER RIVER REDIVERSION PROJECT

LAKE MOULTRIE & SANTEE RIVER SOUTH CAROLINA



GENERAL LAYOUT PLAN FOR
PROPOSED FISH HATCHERY



NERAL LAYOUT PLAN FOR
ROPOSED FISH HATCHERY

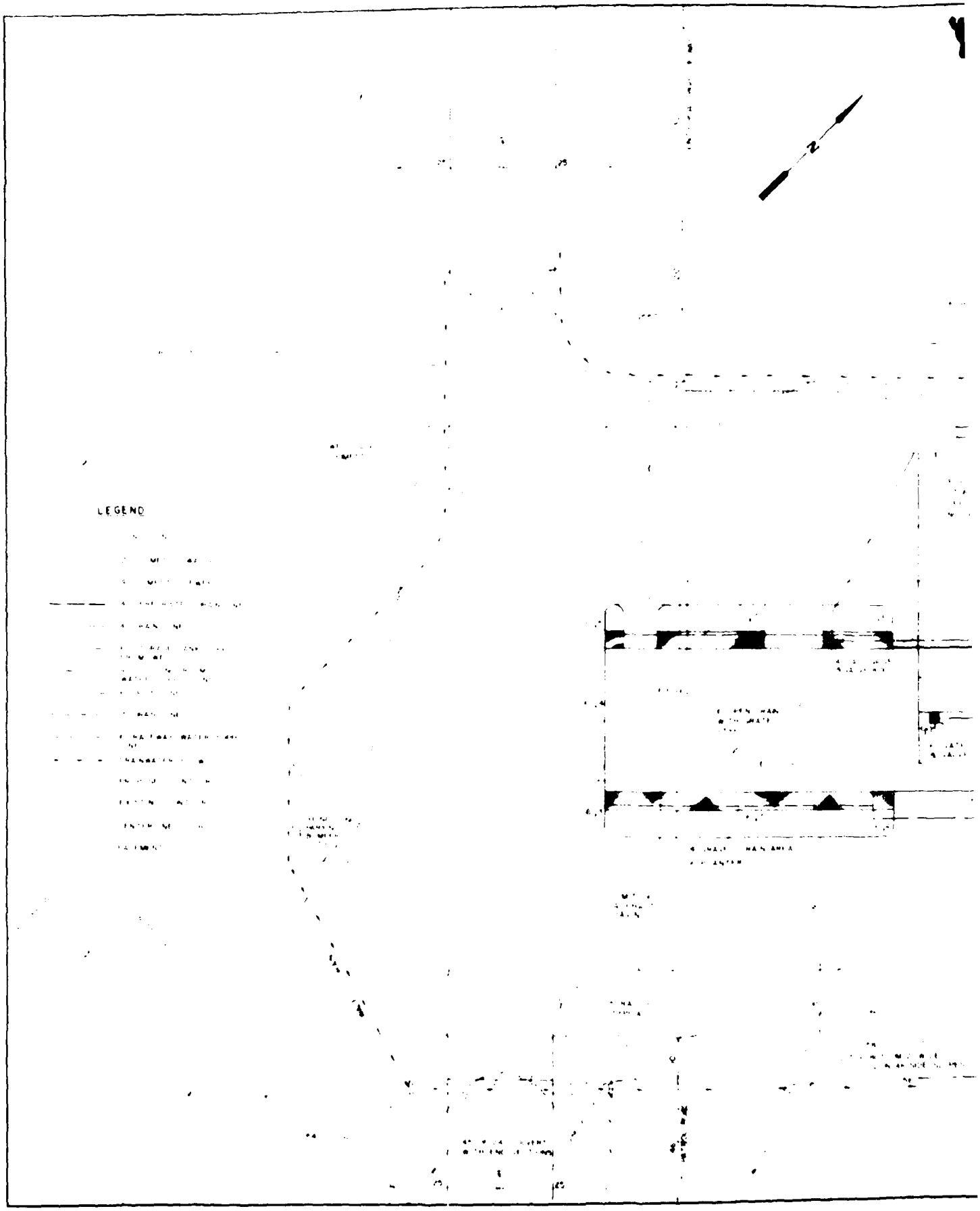
FISH HATCHERY

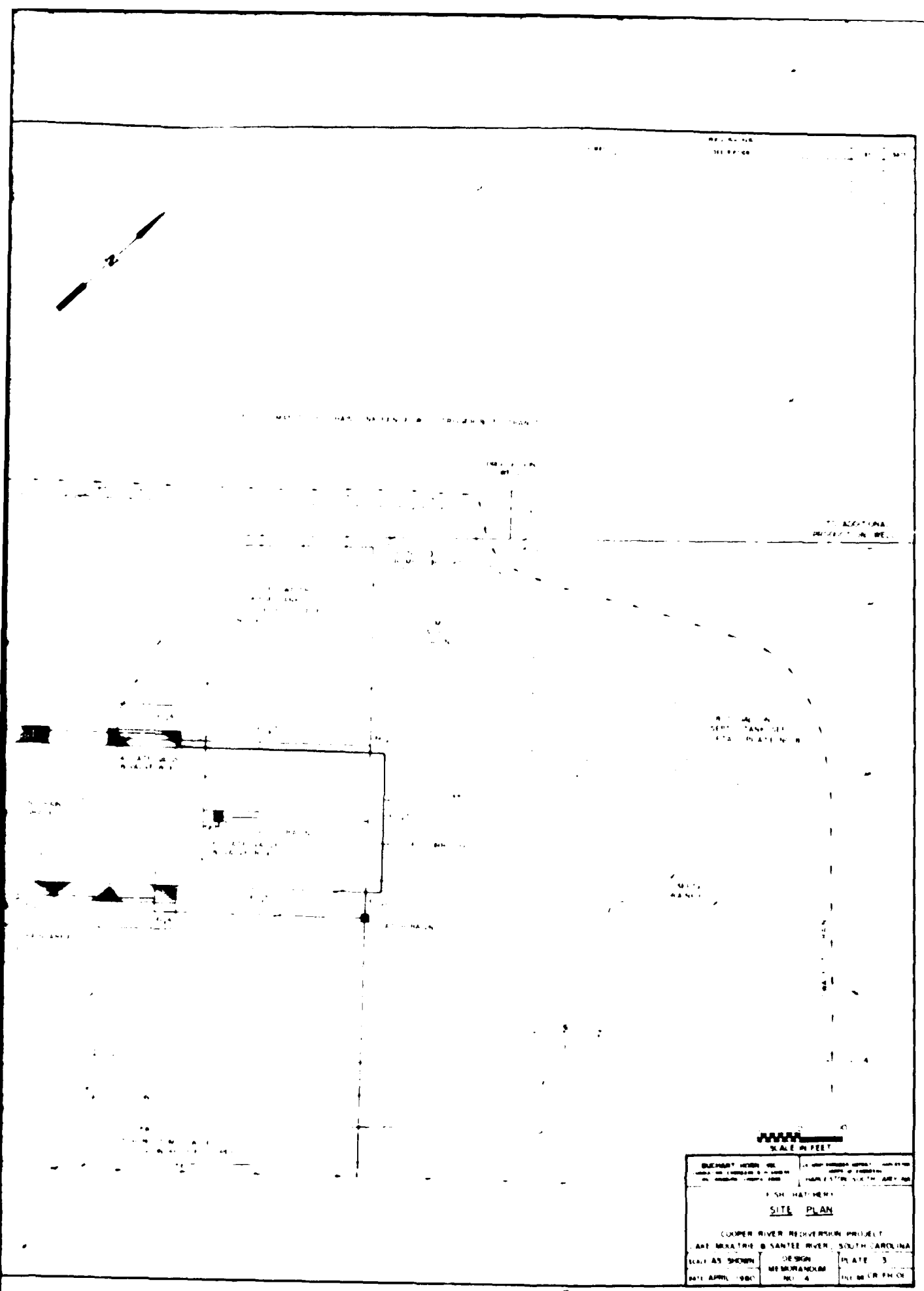
GENERAL LAYOUT PLAN

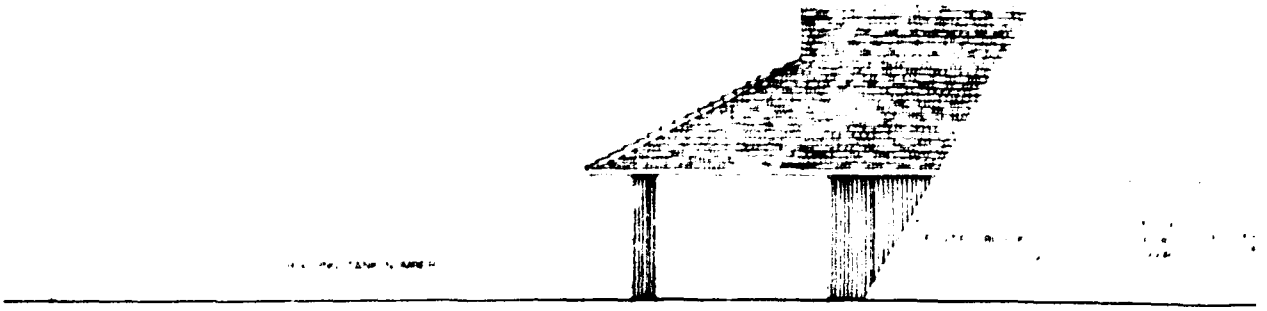
COOPER RIVER REDIVERSION PROJECT

MT. PLEASANT & SANTEE RIVER, SOUTH CAROLINA

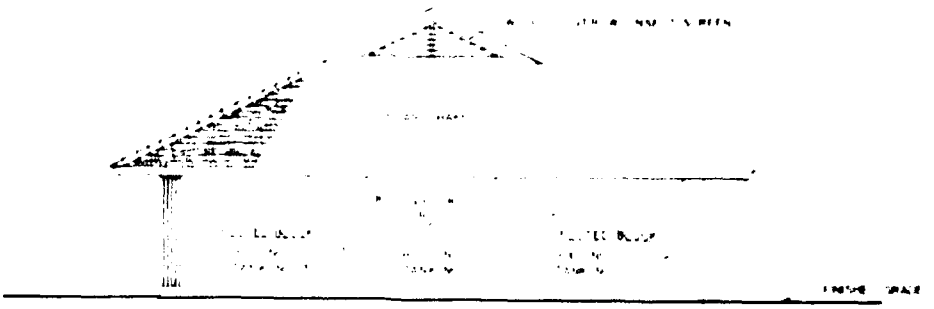
	DESIGN MEMORANDUM NO. 14	PLATE 2


LEGEND

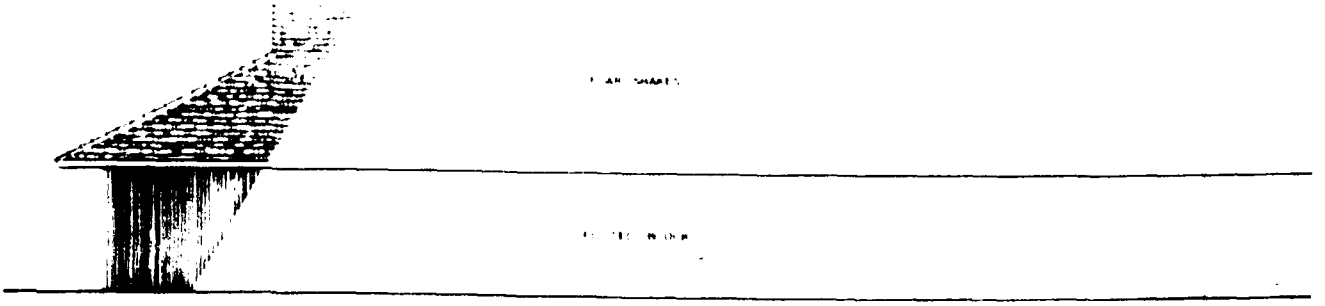

SCALE IN FEET
SITE PLAN
COOPER RIVER RESERVOIR PROJECT
AND MENARDS & SANTEE RIVER, SOUTH CAROLINA
SCALE AS SHOWN
DESIGN MEMORANDUM NO. 4
PLATE 3



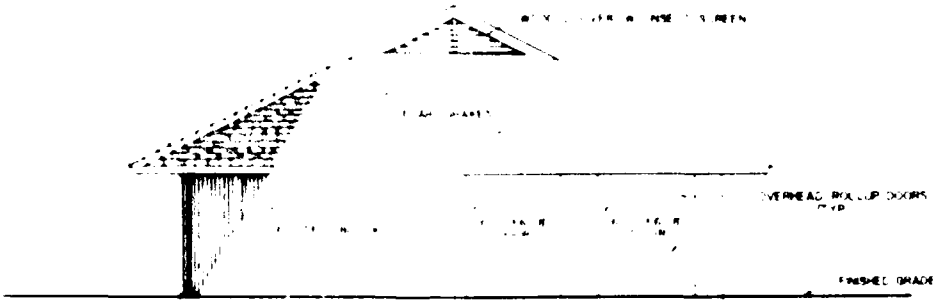
SOUTH ELEVATION



WEST ELEVATION



NORTH ELEVATION



EAST ELEVATION

0 2 5
SCALE IN FEET

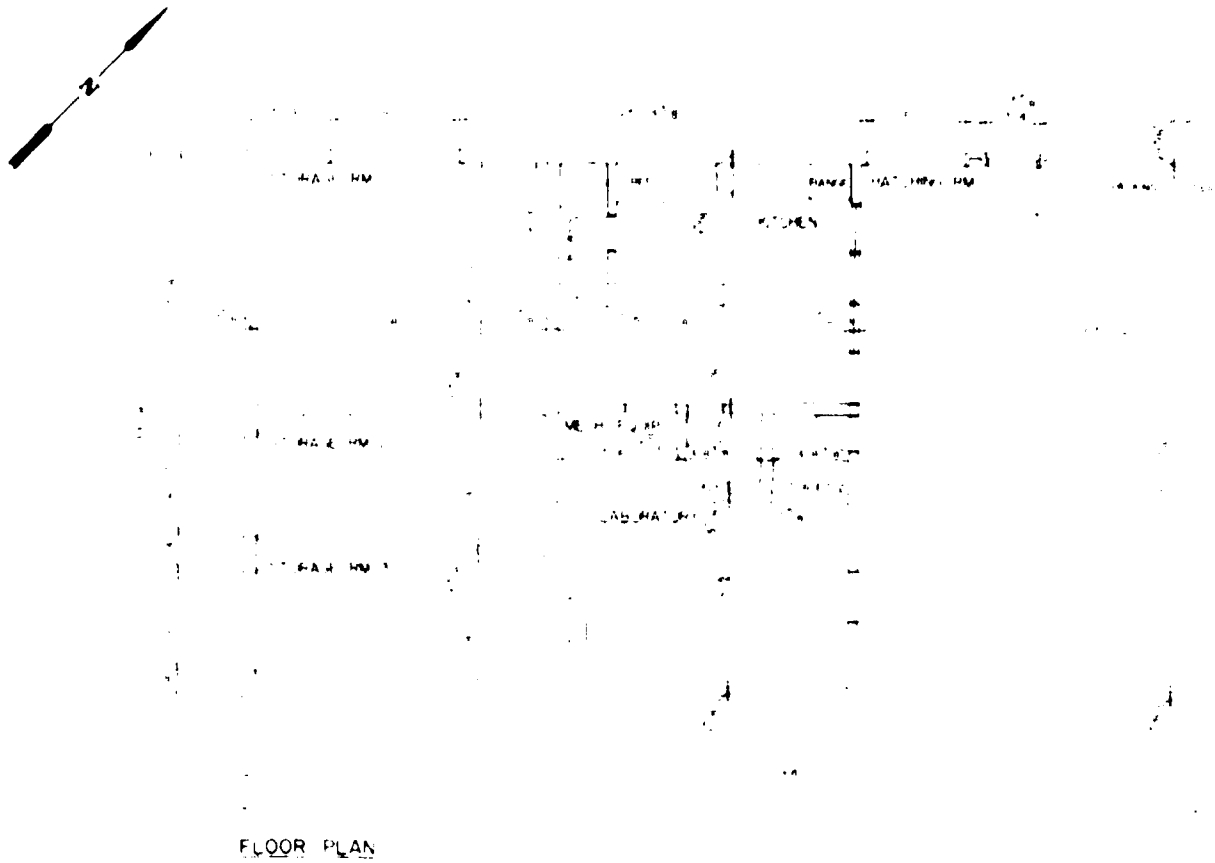
BUCHART HORN INC

FISH HATCHERY

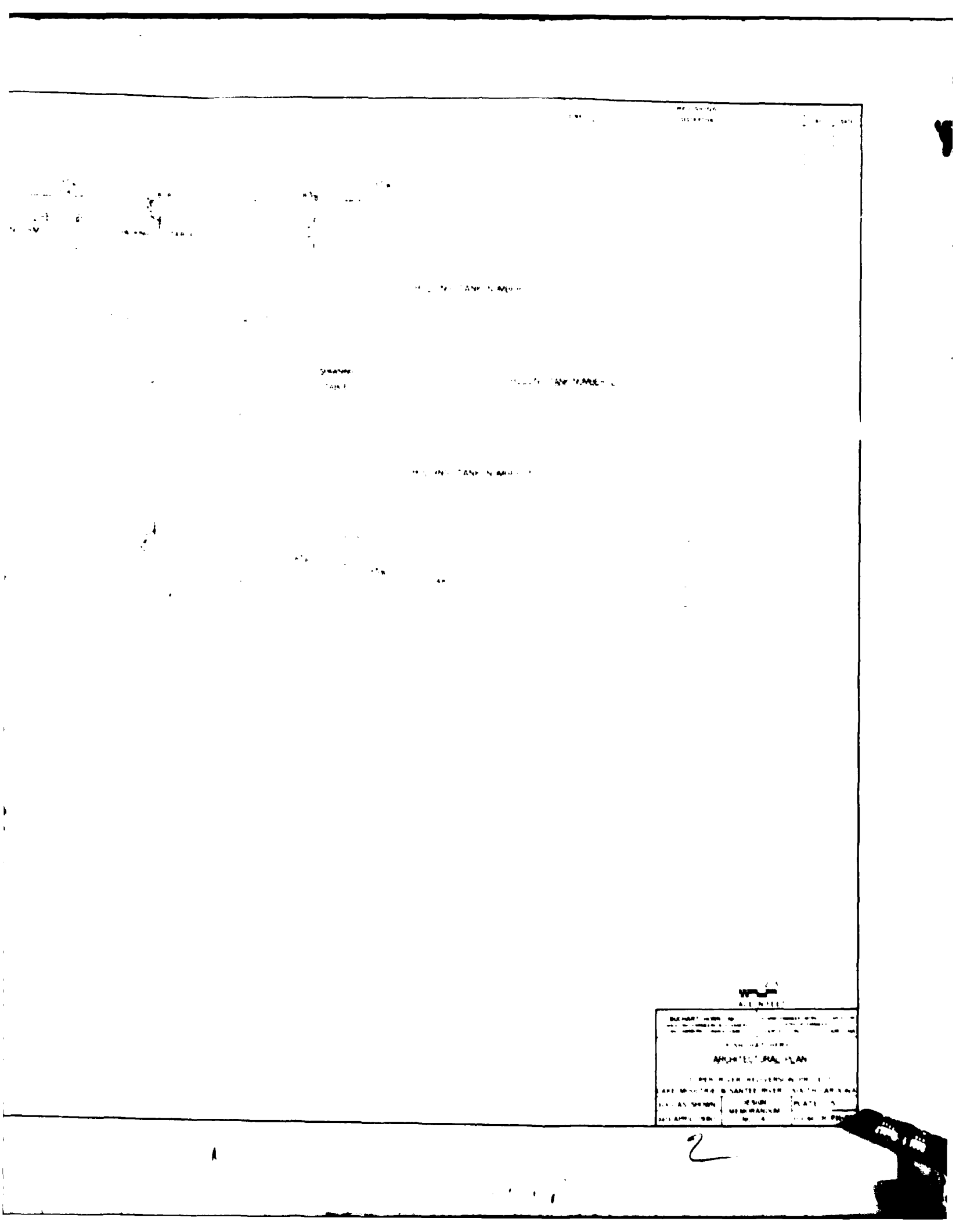
ARCHITECTURAL ELEVATIONS

COOPER RIVER REDIVERSION PROJECT
CHARLESTON & BERKELEY COUNTIES, SOUTH CAROLINA

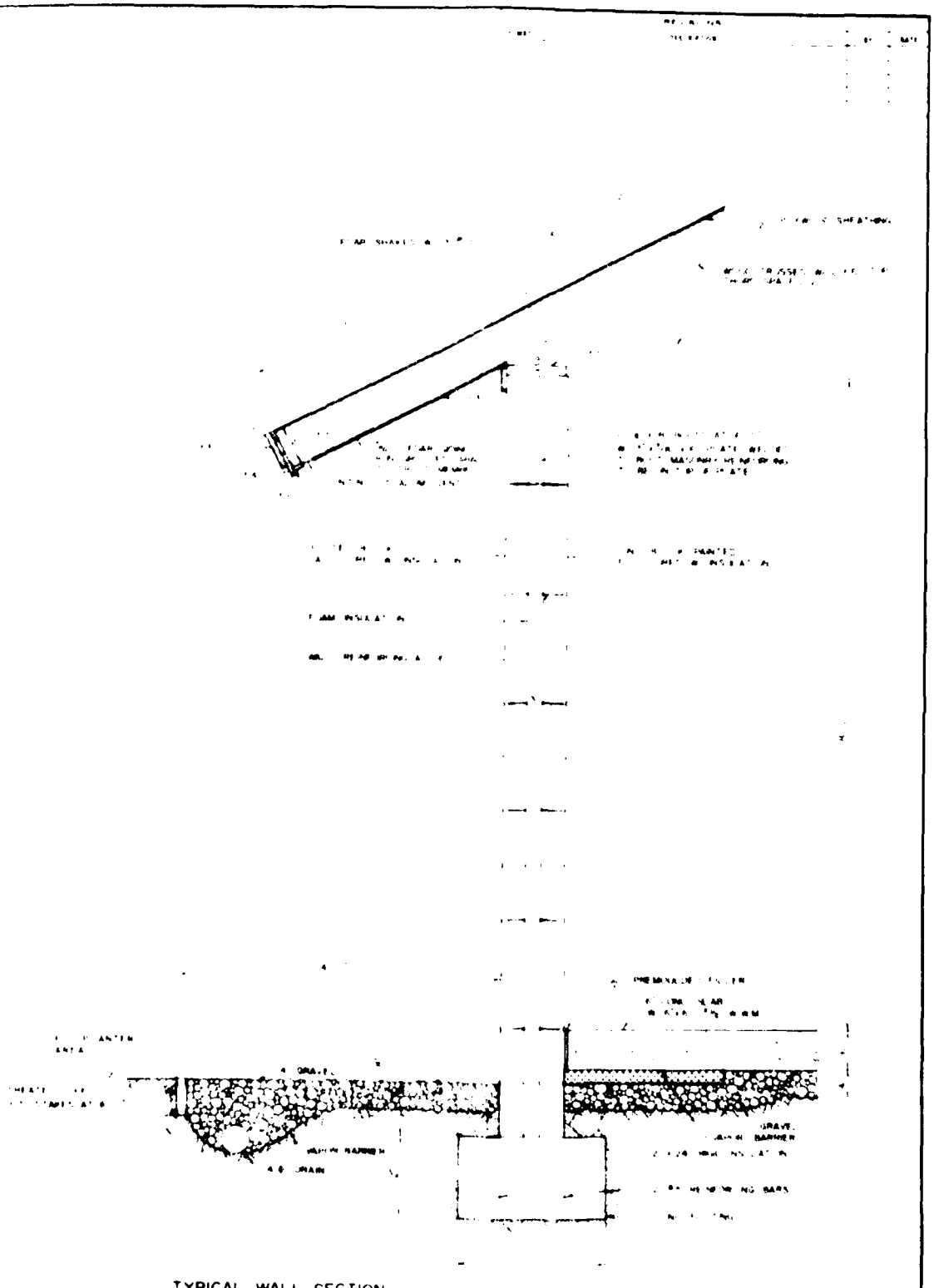
SCALE AS SHOWN	DESIGN MEMORANDUM NO. 14	PLATE 4
DATE APRIL 1980		



FLOOR PLAN


ARCHITECTURAL PLAN

TYPICAL TRUSS DETAIL



TYPICAL WALL SECTION

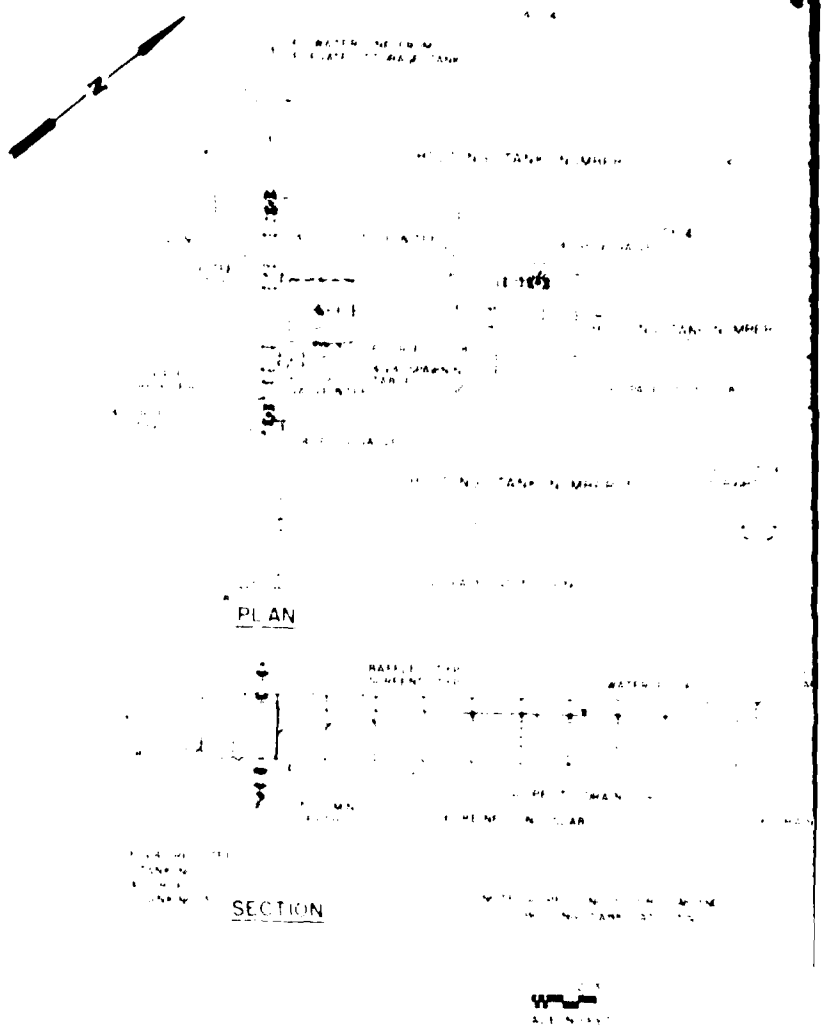
SCALE IN FEET

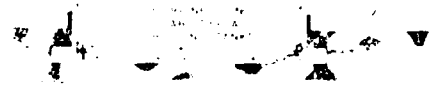
BUCHART HORN INC.

FISH HATCHERY
TYPICAL
WALL SECTION
UPPER RIVER REDIVERSION PROJECT
CAPE ROMAIN & SANTEE RIVER, SOUTH CAROLINA

SCALE AS SHOWN | DESIGN MEMORANDUM NO. 6 | PLATE 6

DATE APRIL 1980


N
PLAN
SECTION



TYPICAL HOLDING TANK SECTION

HOLDING TANKS PLAN & SECTION

CHARLESTON HARBOR DEEPENING PROJECT

CHARLESTON & SANTEE RIVER, SOUTH CAROLINA

PLATE 7

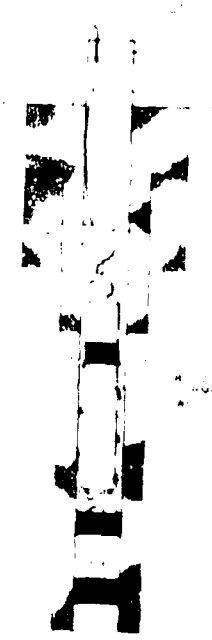
2

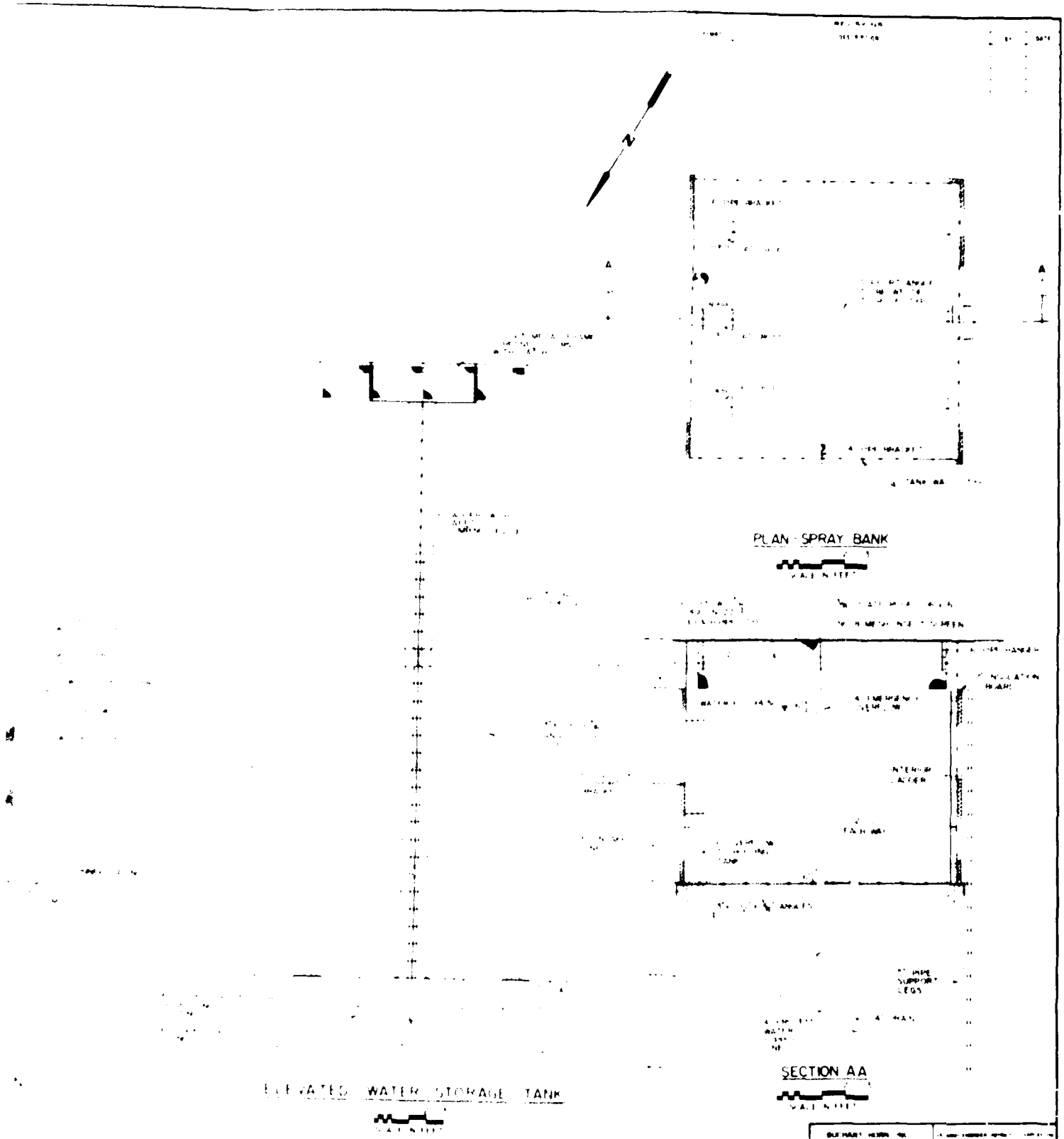
PLAN

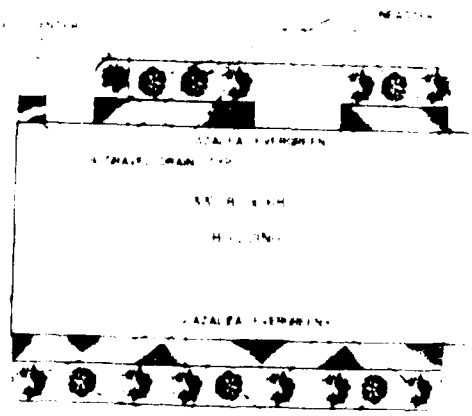
PROCESS WATER PIPING

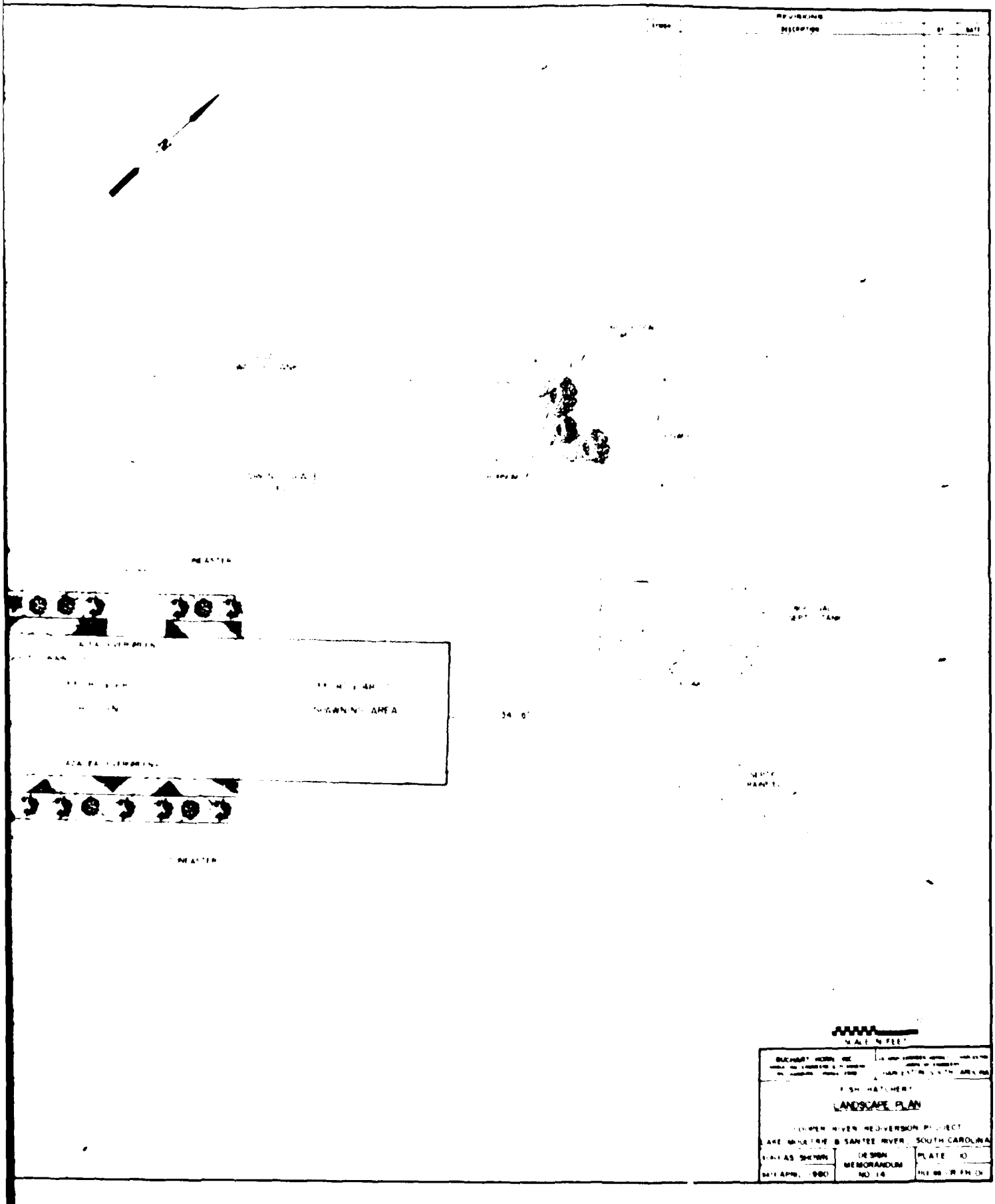
PLAN

PHOTOGRAPH




PLAN - SPRAY BANK
SECTION AA
ELEVATED WATER STORAGE TANK




REVISIONS
DESCRIPTION
DATE
NORTH
SWANNANOA AREA
SCALE IN FEET
FISH HATCHERY
LANDSCAPE PLAN
SANTEE RIVER REDIVERSION PROJECT
LAKE MOULTRIE & SANTEE RIVER, SOUTH CAROLINA
AS SHOWN
APRIL 1980
DESIGN MEMORANDUM NO. 14
PLATE 10

APPENDIX NO. "A"

AGREEMENT

D R A F T

AGREEMENT BETWEEN
THE UNITED STATES OF AMERICA
AND
THE STATE OF SOUTH CAROLINA
FOR LOCAL COOPERATION AT
COOPER RIVER REDIVERSION PROJECT
LAKE MOULTRIE AND SANTEE RIVER
SOUTH CAROLINA

THIS AGREEMENT entered into this _____ day of _____, 1980, by and between the UNITED STATES OF AMERICA (hereinafter called the "Government"), represented by the Contracting Officer executing this Agreement, and the STATE OF SOUTH CAROLINA, acting by and through the South Carolina Wildlife and Marine Resources Department (hereinafter called the "State");

WITNESSETH THAT:

WHEREAS, construction of the Cooper River Rediversion Project (hereinafter called the "Project") was authorized by the River and Harbor Act of 1968 (Public Law 90-483, 90th Congress, August 13, 1968) for the purpose of improving navigation in Charleston Harbor, and,

WHEREAS, the Board of Engineers for Rivers and Harbors has recommended and the project document plan authorizes construction of a new fish hatchery facility as a mitigation feature of the Project; and,

WHEREAS, the State hereby represents that it has the authority and capability to furnish the non-Federal cooperation required by the Federal legislation authorizing the Project and by other applicable law and as stated hereinafter.

NOW, THEREFORE, the parties agree as follows:

1. The State agrees that if the Government will commence construction of a new fish hatchery, substantially in accordance with an engineering plan defined in the Government's Design Memorandum No. 14, Relocation of Fish Hatchery, adjacent to the tailrace canal of the power plant to be constructed near St. Stephens, South Carolina as part of the Cooper River Rediversion Project, the State shall, in consideration of the Government commencing construction of such Project, fulfill the requirements of non-Federal cooperation specified to wit:

a. Accept ownership of the new fish hatchery facility, including full responsiblity for the operation and maintenance of the grounds, buildings, equipment, boat ramp, approaches, and parking area.

b. Release and agree to save and hold the Government harmless from any and all causes of action, suits-at-law or equity, or claims or damages, or from any liability of any nature whatsoever except those claims or damages due to the fault or negligence of the Government or its contractors in any way growing out of the relocation and construction of the aforesaid fish hatchery facility.

2. a. The Government shall make such necessary surveys and prepare such drawings, schedules, plans and specifications in connection with the work to be performed hereunder as may be required. Said drawings, schedules, plans and specifications will be submitted to the State for review and comment prior to initiation of construction.

b. The Government shall acquire perpetual and assignable right-of-way easements or other interests in real property necessary for the project construction. The Government shall, subject to the approval of the Secretary of the Army, convey to the State a perpetual and assignable easement in, on, over and across the land shown by approximation in "red" on a map of the vicinity of the Project, marked Exhibit "A", attached hereto, and by this reference made a part hereof, for the operation and maintenance of the fish hatchery, together with a perpetual road right-of-way easement within the Project area, as shown by approximation in "green" on Exhibit "A", for access to the fish hatchery facility over and across Government lands.

3. The Government, upon completion of the work, shall serve notice upon the State of such Project completion by posting a letter of notification to the Executive Director, South Carolina Wildlife and Marine Resources Department, P. O. Box 167, Dutch Plaza, Building D, Columbia, South Carolina, 29202. Receipt of the notice shall constitute acceptance of the work performed by the State under the terms of this Agreement unless written objections are received by the Government within twenty (20) days thereof.

4. Should the State ever cease operation of the fish hatchery, the facilities and easements shall immediately revert to the Government and may be used for any purpose in the discretion of the Government.

5. This Agreement is subject to the approval of the Secretary of the Army or his designated representative.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first written.

THE UNITED STATES OF AMERICA

APPROVED:

BY _____
Colonel, Corps of Engineers
District Engineer
Contracting Officer

FOR THE SECRETARY OF THE ARMY

DATE: _____

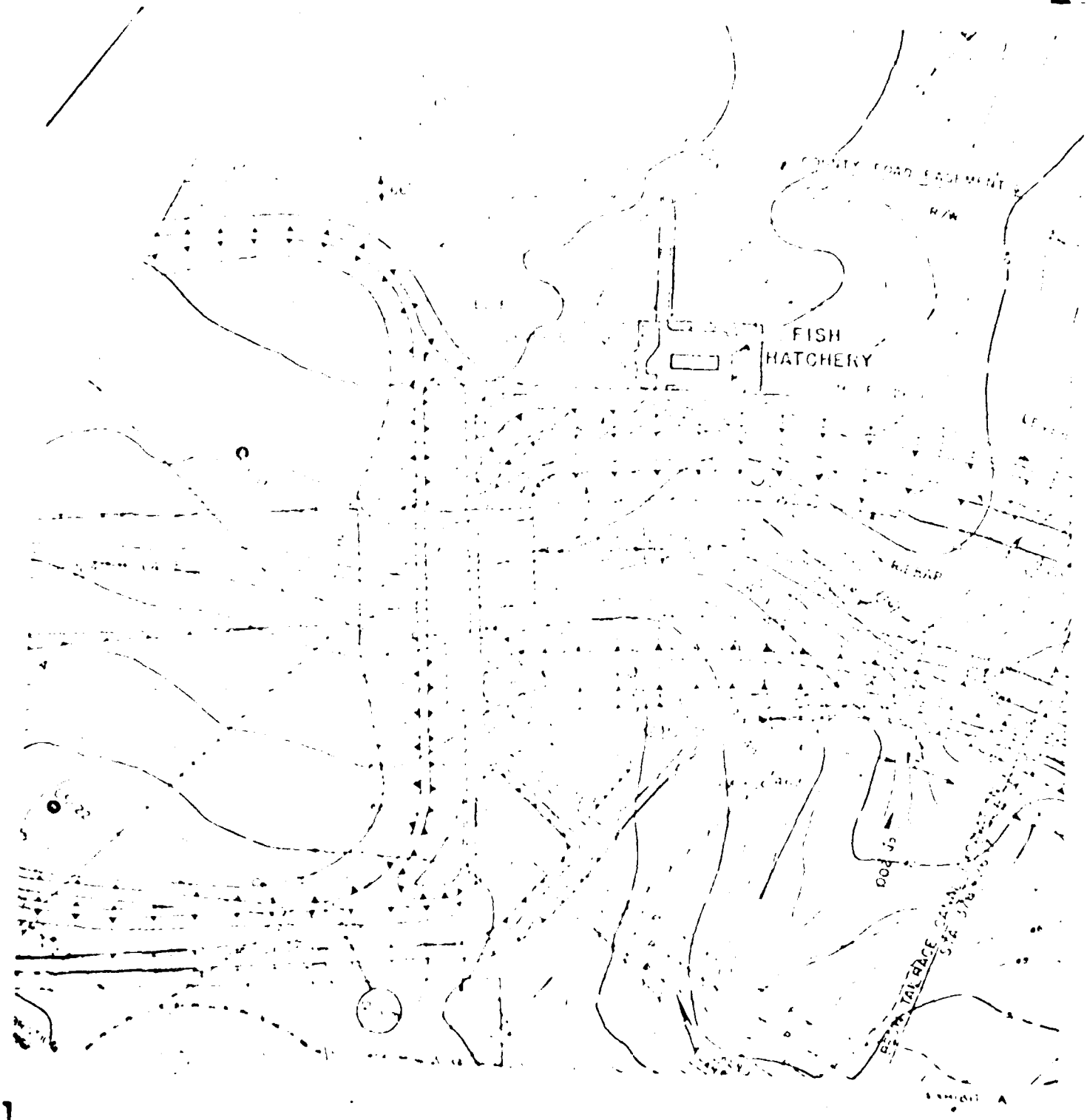
THE STATE OF SOUTH CAROLINA

BY _____

DATE: _____

ATTEST: _____

DATE: _____


FISH
HATCHERY

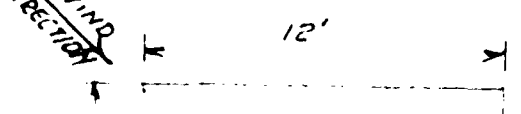
APPENDIX NO "B"

STRUCTURAL DESIGN COMPUTATIONS

BY: [illegible] DATE: 5-80 SUBJECT: US Corp Eng
CHKD BY: [illegible] DATE: [illegible] South Carolina Fish Hatchery
Preliminary Design

SHEET NO. 1 OF 5
90116-10
REV. 1

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS



Scale 1"=6'-0"

ELEVATION

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY _____ DATE 6-5-90 SUBJECT _____ SHEET NO 2 OF 5

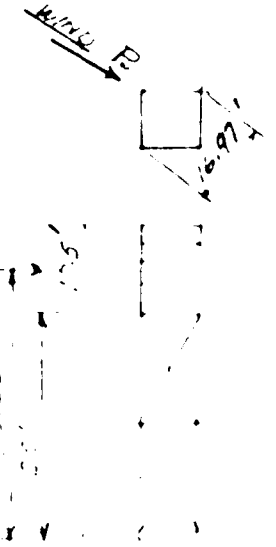
CHKD BY _____ DATE _____ JOB NO 87116-10

REVISED REV 1

Surface area = 16.97'(10.5' + 1') = 178.2 sq ft ; one side only 12x10.5 high = 126 sq ft.

Wind pressure = 36 lbs per sq ft FOR 130 mph (ANSI A58.1-1982)

WIND ON SIDES



P_w = 178.2 sq ft (36 lbs/sq ft) = 6.42 kip

M = 6.42^K (30.25') = 194.21 ^K-ft

Stress in leg at ground = $\frac{194.2^{K'}}{16.97'}$ = 11.5^K wind + D.L.

D.L. + water:

assume water stored in tank

wt. water = 12' x 12' x 10.2 lbs/cu ft = 14.7 kip

Tank wall 3' on centers

around outside edges.

Tank 12' x 12' x 10.2 lbs/cu ft = 3.917 ^K

Steel per tank wall 6.5' x 4 walls = 3.120 ^K

Top floor (12' x 12' x 3' x 150 lbs/cu ft) = 4.406 ^K

11.443 ^K

∴ Vertical load water & tank

D.L. { water 77 ^K
steel 11.4 ^K
88.4 ^K

STRESS PER LEG

D.L = 88.4 ÷ 4 LEGS = 22.1 ^K per leg

wind = ±11.5^K in one leg, in other 22.1 - 11.5 = 10.6 ^K

Wind on one side only 126 x 36 = 4.54 kips

M = 30.25 x 4.54 = 137.3 ^K-ft

Stress in leg at ground $\frac{137.3}{12}$ = 11.4 ^K in legs

Load per leg = $\frac{11.4}{2}$ = 5.7^K tension

Total load = 5.7 + $\frac{19.5}{4}$ $\frac{11.4}{4}$ =

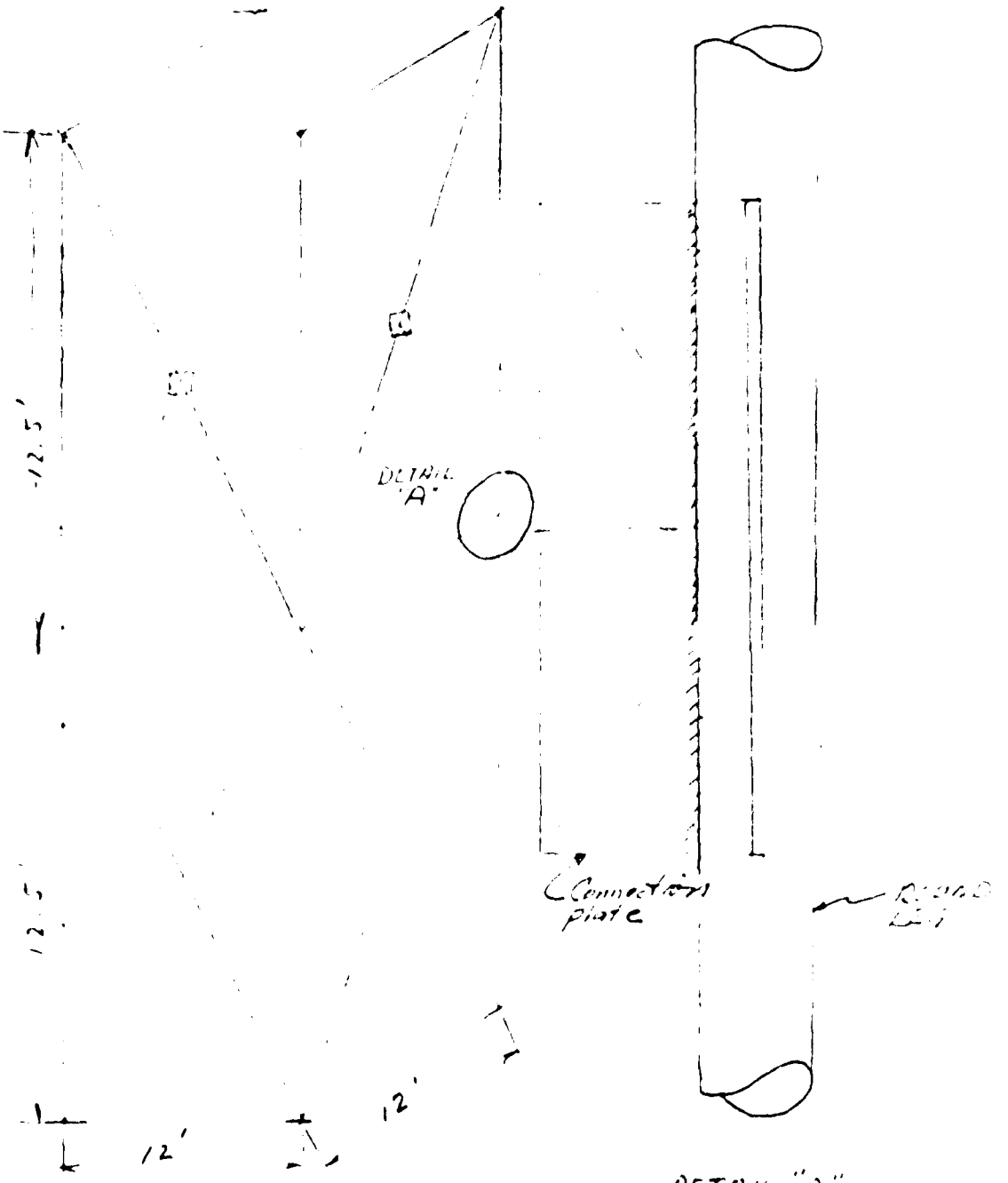
5.7 + 19.1 + 2.85 = 27.65^K per leg

No water — uplift = -5.7 + 0 + 2.85 = -2.85^K

BY _____ DATE 6-5-80 SUBJECT US Corps Eng SHEET NO 3 OF 5

CHKD BY _____ DATE _____ Preliminary Design JOB NO 2011-10 Charleston S.C. REV. 1

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS



DETAIL "A"

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY _____ DATE 6-5-86 SUBJECT Re-Computing SHEET NO 1 OF 5

CHKD BY _____ DATE _____ JOB NO _____

Revised 5-2 Rev. 1

Legs: Solid Stress in leg = 11.5 (wind) × 77 (area) / 4 + 11.4 (gravity) = 33.6 K

A = stress / unit stress = 33.6 / 11.5 = 5.84 Sq. in.

3½ Solid Rod	4" Round Pipe	5" Round Pipe
.226" wall thickness	.237" wall thickness	.258" wall thickness
A = 2.405 Sq. in.	A = 3.17 Sq. in.	R = 4.30
r = 1.32 in.	r = 1.51	r = 1.98
wt. = 8.11 lbs/ft	wt. = 9.72	wt. = 10.62
unit stress = 33.6 / 2.405 = 13.97 psi	33.6 / 3.17 = 10.60 psi	
Actual 911.65	Actual 1079	Will use 1082 lbs

Check N

25 × .4 = 6.25

KL/r = 24(12) / 1.32 = 64.66

KL/r = 6.25(12) / 1.51 = 49.67

25-2 = 12.5'

KL/r = 12.5(12) / 1.32 = 113.64

KL/r = 12.5(12) / 1.51 = 99.34

O.D. = 4.5"

I.D. = 4.26"

Use 5" Sch 40 pipe

Check N = 6.42

Use 3½ Solid Rod 2.12

8.56 K

(12.33 / 12) 8.56 = 12.36 Kips Tension Capacity of 3½ Rods

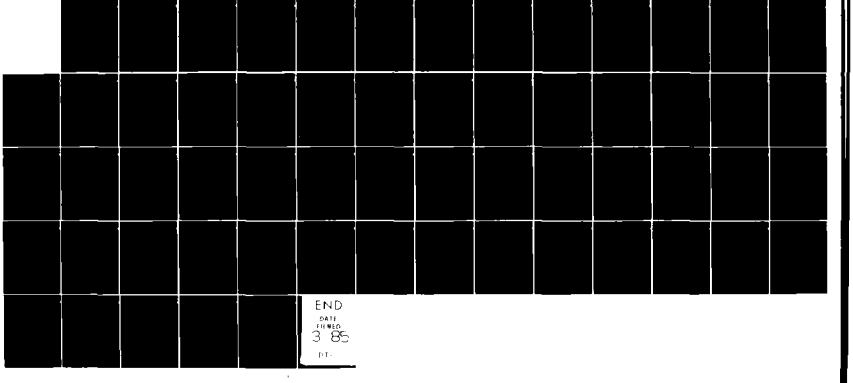
Design Loading 12.56 / 2 = 6.28 K OK

Use L3 × 3½ × 3/8 with A = 1.92 sq. in.

f/A = 11.25 / 1.92 = 5.90 psi OK

AD-A149 607 COOPER RIVER REDIVERSION PROJECT LAKE MOULTRIE AND SANTEE RIVER SOUTH CAROLINA FISH HATCHERY(U) CORPS OF ENGINEERS CHARLESTON SC CHARLESTON DISTRICT JUL 80 2/2

UNCLASSIFIED F/G 6/3 NL



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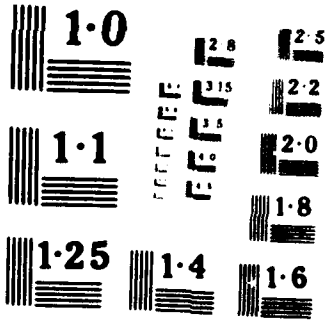

1·0
2·8
3·15
3·5
2·5
2·2
2·0
1·8
1·1
1·25
1·4
1·6

BY ____ DATE 6-5-8 SUBJECT U.S. Corp Eng ____ SHEET NO 5 OF 5
CHKD BY ____ DATE ____ South Carolina Fish Hatchery JOB NO 90116-10
Preliminary Design Rev. 1

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

FOOTINGS

Footing loads

MAXIMUM + FULL WATER + Legs

wind	11.5
water & Tank	22.1
Leg 25'x11.6#/ft +15% =	0.4
	34.0 K

Min: -wind, no water

wind	= 11.5
Tank 11.4 ÷ 4	= 2.85
1 Leg	= .40
	-8.25 uplift

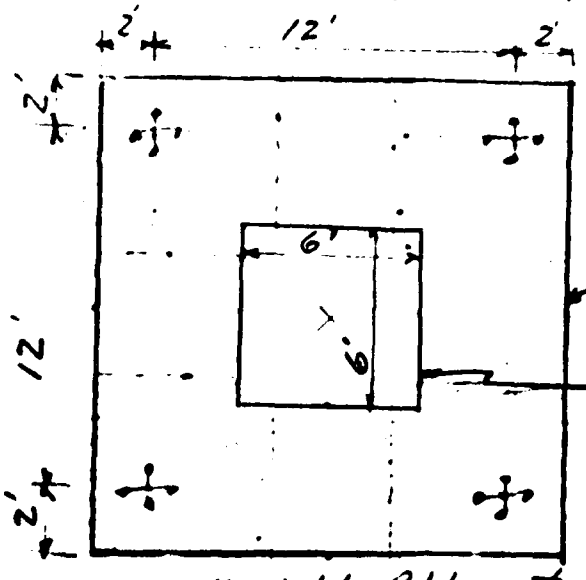
Assume allowable bearing pressure on soil at 1500 lbs per sq. ft.

Area required = $\frac{34.0^K}{1.5^K/sq.ft}$ = 22.7 Sq. Ft.

$\sqrt{22.7}$ = 4.76' say 4'-9¼" square

weight of Cone

4.76 x 4.76 x 1' x 150 = 3.4 K



Footing & Valve Pit Layout

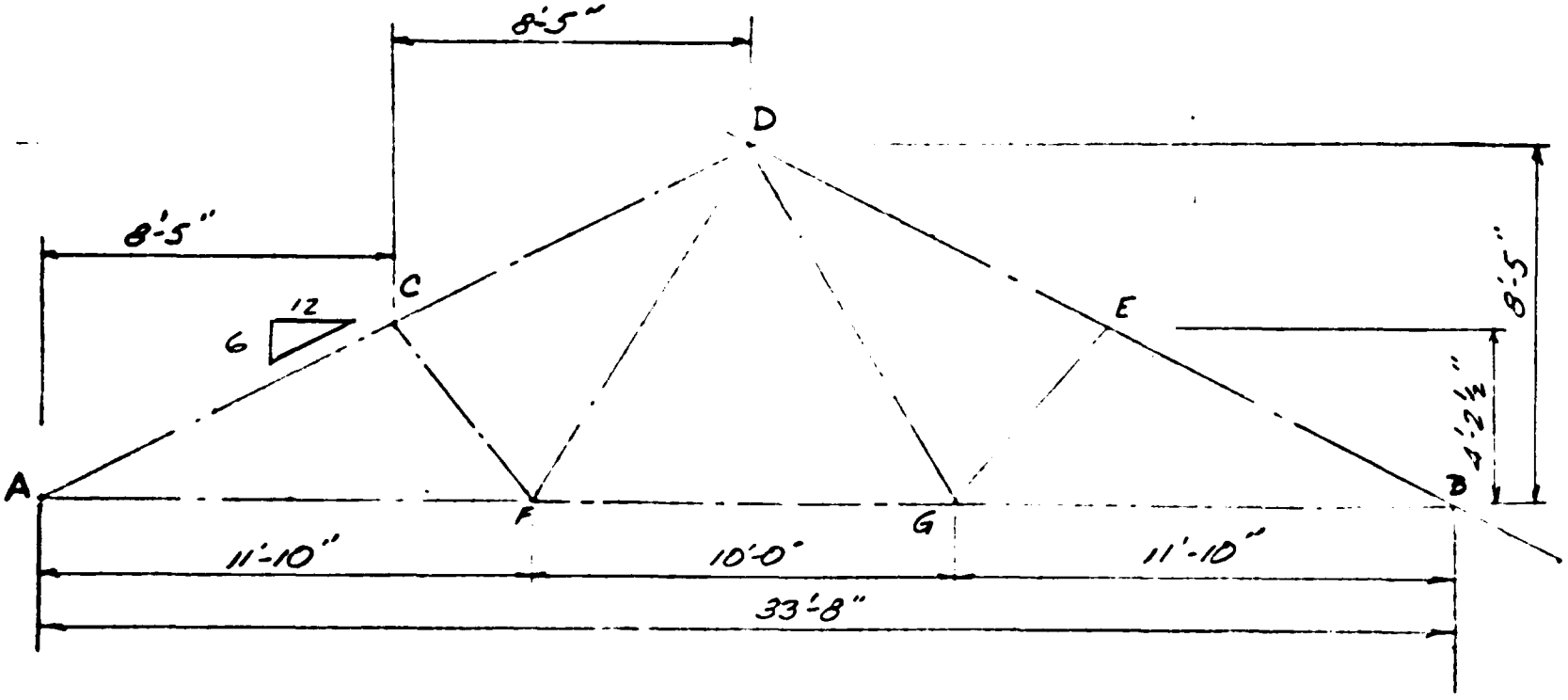
Scale 1" = 6'

2.1' thickness
8.49 K for uplift

Use 6'x6'x150x1'-0" thick for uplift

Footing Slab 16'x16'x1'-8"

Valve Pit 6'x6'x3' deep



WOOD ROOF TRUSS

COOPER RIVER REDIVISION PROJECT
FISH HATCHERY ROOF

90116-10

BUCHART-HORN CONSULTING ENG'S.
Williamsburg Va.

BY CB DATE 6-19-80 SUBJECT _____ SHEET NO. 2 OF 6

CHKD BY TCH DATE 6-20-80 Fish Sanctuary - Roof JOB NO. 90116-10

Cooper River Redivision Proj, Santee River South Carolina

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

Roof loads

Min. Live loads Table 710. BOCA Building Code 1978

Contributing area to truss

Truss @ 2' c.c. × 33.67 = 67.34 Sq. Ft. ∴ in 0 to 200 Cl.

LL. = 16 lbs per Sq. Ft. of Horizontal projection

Snow load = 10 lbs per Sq. Ft. of horizontal projection (A 711.1 Fig'L-102.1c 100 yr. Rec. Int.)

wind load = 13 lbs. per Sq. Ft. acting Normal to Roof (Table 712.1 from Min. BOCA)

wind load on inclined surfaces A 714.1

Ratio sidewall height to building width = $\frac{8}{33.67}$ = .23 < .3

windward Slope ∠ with horiz 30°

∴ modification of Section 712.1 is 0.3 for inclined surfaces and -.7 for leeward slopes

that is 13 lbs per Sq. F. × .3 = 3.9 lbs per Sq. Ft. acting normal to roof surface.

leeward slope 13 lbs per Sq Ft × -0.7 = -9.1 lbs per Sq Ft. acting normal to roof surface.

Note: to check up-lift assume 130-140 mph wind. ∴ use -.7(40 Psf) = 28 psf use one side only.

Summary of applied loads.

L.L. = 16 lbs. per Sq. Ft

Snow load 10 lbs. " " "

wind : 3.9 lbs per Sq. Ft. wind speed 90 mph

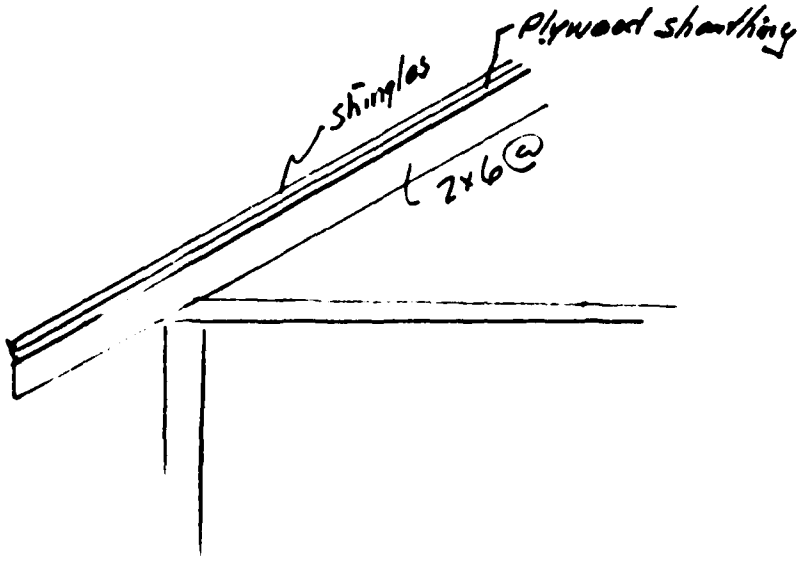
-9.1 lbs per Sq. Ft. " " 90 mph

28 lbs per Sq. Ft. " " 130+40 MPH.

BY [illegible] DATE 6-19-80 SUBJECT _____ SHEET NO. 3 OF 6

CHKD. BY TCY DATE 6-20-80 Fish Hatchery Roof JOB NO. 80116-1

Cooper River Rediversion Proj Santee River South Carolina



BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

Asphalt shingles 2 lbs per Sq. Ft.
Sheathing 3 lbs per Sq. Ft.
1 (2x6) 3 lbs per ft.
Ceiling 2 lbs per Sq. Ft.
1 (2x4) 2 lbs per ft

Dead load per truss

Shingles + sheathing 5 lb:/sqft (28ft) = 10 lbs per Lin Ft of truss

Truss

T.C.	2(18.86')	2# =	113.16
B.C	33.67'	2# =	67.34
Webs	2(10')	2# =	40
	2x(5.5)	2# =	72

292.50 lbs D.L. in each truss

292.5 ÷ 33.67 = 7.20 lbs per ft of truss

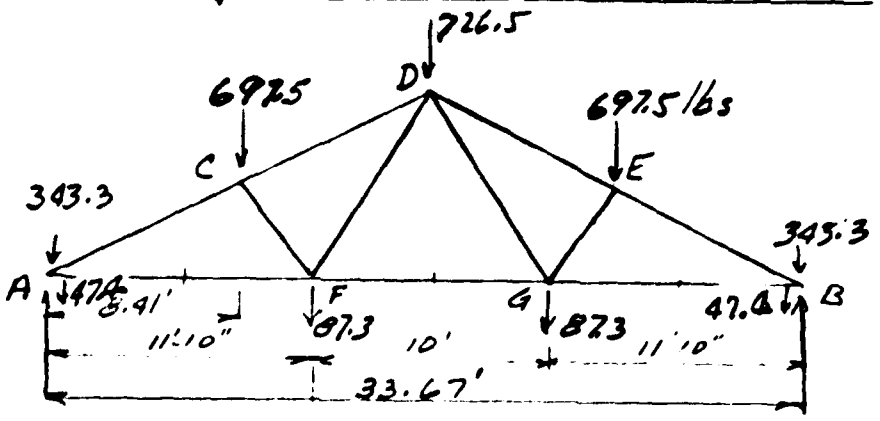
Shingles + Sheathing 2(2+3) = 10. lbs per ft. of truss

DL = 17.20 lbs per ft

BY _____ DATE 6-19-90 SUBJECT _____ SHEET NO. 4 OF 6

CHKD. BY TCP DATE 6-20-90 Fish Hatchery Roof JOB NO. 90116-10

Cooper River Reclamation Proj. Santee River, South Carolina



Panel point loads

Top chord

Rafter 2x6 = 3 lbs/ft

Shingles/sheathing = 10 lbs/ft²

DL = 13 lbs/ft. of span per truss

LL = 32 lbs " " " "

Snow L = 20 lbs " " " "

65 lbs. DL+LL+Snow

Wind = 7.8 lbs " " " " (one side only)

-18.2 lbs " " " " one side only

-DL+LL+SL

A = 9.43÷2 (65) = 306.47 lbs

- w = 9.43/2 (18.2) = -85.90 ΣA = 345.29

+ w (7.8) = +36.82

C = 9.43 (65) = 612.95

-w 9.43 (18.2 = -171.63 ΣC = 697.49

+w 9.43 (7.8) = + 73.55

wall 5.5(2) = 11.

D = "C" 612.94

See - 171.63 ΣD = 726.49

73.55

10 (2) 2 = 40.

$R_A = 345.3 + 47A + 697.5 + 873 + \frac{726.5}{2} = 1540.7$

Bottom Chord

F = (5+5.92) 2 = 21.84 Bot.

3 lb (10.92) (2') = 65.5 ceiling

87.34 lbs

A. Bot Chord

(5.92)(2) = 11.83

(2)(37.2)(3) 35.52

47.35 lbs

BUCHART - HORN

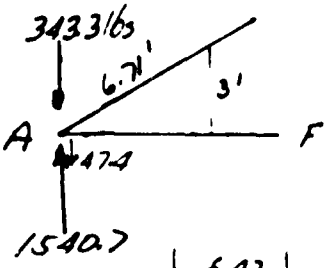
CONSULTING ENGINEERS AND PLANNERS

BY _____ DATE 6-19-80 SUBJECT _____ SHEET NO. 5 OF 6

CHKD. BY TCG DATE 6 20 80 JOB NO. 90116-10

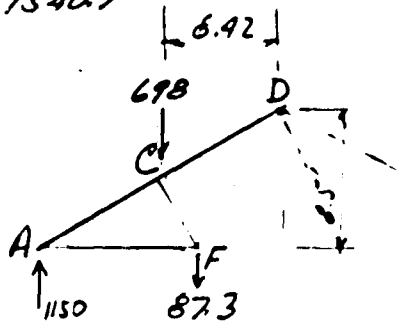
Cooper River Realignment Proj. Santee River, South Carolina

C



$$AC = \frac{1540.7 - 390.7}{3}(6.71) = 2572 \text{ lbs}$$

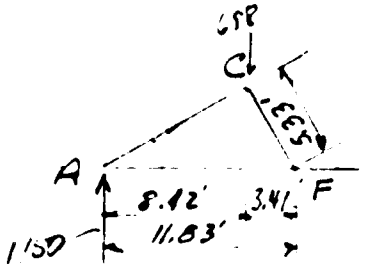
$$AF = 1150(6) \div 3' = 2300 \text{ lbs}$$



$$m_D = \left[-87.3(5.00) - 698(8.42) + 1150(16.83)\right] \div 8.5$$

$$= -436.5 - 5877.2 + 19354.5$$

$$= \frac{13040.8}{8.5} = 1534.2 \text{ lbs} = FG$$



$$m_F = \left[+1150(11.83) - 698(3.41)\right] \div 5.33$$

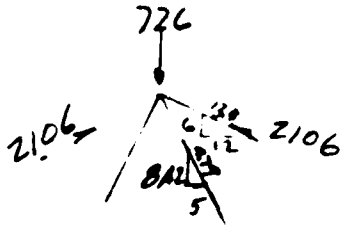
$$13604 - 2380$$

$$= \frac{11224}{5.33} = 2106 \text{ lbs} = CD$$

Max unit stress in wood members

T. Chord — $2572 \text{ lbs} \div 9.14 \text{ sq in} = 281 \text{ lbs per sq in}$.

Bot Chord $2300 \text{ lbs} \div 5.89 \text{ sq in} = 390 \text{ lbs per sq in}$.



$$\Sigma V = -726 + \frac{2106}{13.4}(6)2$$

$$= -726 + 1886 = 1160 \text{ lbs}.$$

$1160 \div 2 = 580 \text{ lbs per web member}$

$$\frac{580 \text{ lbs}}{8.42'}(9.79') = 674 \text{ lbs} = DF = DG$$

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY [illegible] DATE 6-1980 SUBJECT _____ SHEET NO. 6 OF 6

CHKD BY JCY DATE 6-20-80 Fish Hatchery Roof JOB NO 7811b-16

Copper River Division Proj. Gravel River South Extension

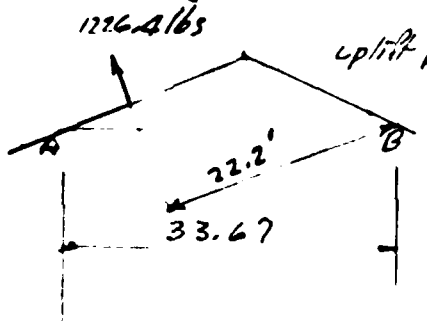
max. uplift.

Leeward side only

use 28 psf. Normal to Roof

(21.9) (2' wide) 28 psf = 1226 4 lbs

1519
600 lbs
910 lbs

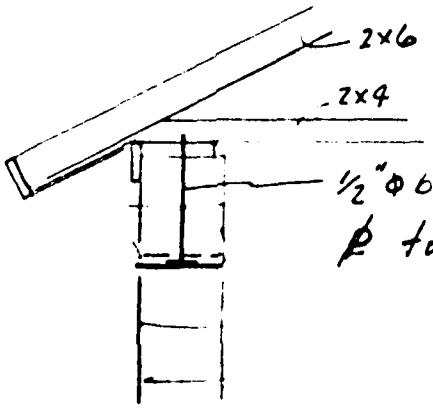


uplift R_A = 1226 4 lbs × 22.2 ÷ 33.67 = 1808 6 lbs per truss

vertical = ↓ 154 1

Net reaction down ↓ 732 lbs

∴ use nominal tie down Bolts at 6' c to c. with plate welded to bottom of bolts. Plate to be below masonry wall reinforcement.



½" ϕ bolts with 3"x6"x ⅜ ℔ welded to bolt

℔ to be placed below wall reinforcing wire truss.

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

APPENDIX NO. "C"

HYDRAULIC COMPUTATIONS

BY TCY DATE 6-7-80 SUBJECT C.C.E. - S.C. SHEET NO 1 OF
CHKD BY DT DATE 11-13-80 ELK HATCHERY JOB NO 90116-10
REVISED 6-17-80 TCY

I. WATER DEMAND

A. HATCHING PROCESS : 1 LITER/MIN./JAR

HATCHING ROOM – 200 JARS
LABORATORY 20
220 JARS x 1 = 220 LITERS/MIN.
x 0.2642 = 58 GPM
USE 60 GPM

B. BROODFISH POOL

CROSS SECTION AREA = 6'x3' = 18 ☐
TOTAL LENGTH OF POOL = 72'
VOLUME = 18x72 = 1,296 C.F.

USE 1 TURNOVER PER HOUR

1 x 1,296 = 1,296 C.F./HR /3600 = 0.36 CFS
x 450 = 162 GPM
USE 170 GPM

C. SMALL POOL – MINIMUM REQUIREMENT : 50 GPM

D. OTHERS (KITCHEN, REST ROOM, HOSE BIBS) : 10 GPM

TOTAL WATER DEMAND = 290 GPM
USE 300 GPM

E. PROVIDE TWO WELLS WITH TWO WELL PUMPS RATED AT 300 GPM EACH.

F. TOTAL DYNAMIC HEAD :

STATIC HEAD: ELEVATION AT DISCHARGE 94'
WATER LEVEL DRAWDOWN (-62)
STATIC HEAD 156'

FRICTION LOSS (C=100)

150' OF 4" PIPE @ 300GPM	9.4x1.5 =	14.1
2000' OF 6" PIPE @ 300GPM	1.3x20	26.0
40' OF 6" PIPE @ 300 GPM	1.3x0.4 =	0.5
HEAD AT DISCHARGE (10PSI)		23
	FRICTION HEAD =	63.6'

TOTAL DYNAMIC HEAD = 219.6 FT.

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY TCY DATE 2-12-80 SUBJECT C.O.G. - S.C. SHEET NO 2 OF 4
CHKD BY EET DATE 4-25 FISH HATCHERY JOB NO 90116-10
REVISED 6-17-80 TCY

II. GROUNDWATER HYDROLOGY

THE FOLLOWING CALCULATIONS WERE BASED ON THE DATA PRESENTED IN "THE EFFECT OF THE COOPER RIVER REDIVERSION CANAL ON THE GROUND-WATER REGIMEN OF THE ST STEPHEN AREA, SOUTH CAROLINA" BY USGS + WATER RESOURCES DIVISION, COLUMBIA, S.C., OCTOBER, 1975.

AQUIFER 2 - DRAWDOWN

$s = \frac{114.6}{T} Q L(U,V)$, WHERE $U = \frac{1.87 r^2 S}{T t}$

$V = \frac{r}{2}\left(\frac{K'}{b'T}\right)^{1/2}$

USE $S = 1 \times 10^{-4}$, $T = 3,400$ GAL/DAY/FT

$\left(\frac{K'}{b'T}\right)^{1/2} = 3.35 \times 10^{-4}$, $t = 60$ DAYS

T (FT)	1/U	V	L(U,V)	s (Q=300 GPM)	s (Q=150 GPM)
750	1.94×10^3	0.13	6.5	65.7	32.9
1,000	1.09×10^3	0.17	5.5	55.6	27.8
2,000	2.73×10^2	0.34	4.0	40.5	20.3
3,000	1.21×10^2	0.50	2.7	27.3	13.7

ALTITUDE OF WATER LEVEL (Pg 42) 36 MSL
ALTITUDE OF BOTTOM OF AQUIFER 2 (Pg 30) (-93) MSL
DIFFERENCE 129 FT

THE REPORT INDICATED THAT AQUIFER 2 WAS PUMPED AT 154 GPM FOR 2 DAYS WITH A MAXIMUM DRAWDOWN OF 69.5 FT. IN THE PUMPED WELL NEAR THE POWER HOUSE SITE (Pg 37)
(SPECIFIC CAPACITY 2.4 GPM/FT. DRAWDOWN, WATER LEVEL = 38.9 MSL.)

SET THE WELL PUMP AT 300 GPM AND KEEP THE TWO WELLS 2,000 FT. APART.

DRAWDOWN = 55.6' x 2 = 111.2'

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY TCY DATE 4-25-80 SUBJECT C.C.E.-S.C. SHEET NO 2A OF ____
CHKD BY ____ DATE ____ FISH HATCHERY JOB NO 20116-10

AQUIFER 2 DRAWDOWN

THE FOLLOWING COMPUTATIONS ARE BASED ON THE DATA IN D.D.M. #6

USE JACOB EQUATION: $T = \frac{264\,Q}{S_2 - S_1} \log \frac{t_2}{t_1}$

WHERE $Q = 300$ GPM, $T = 3776$ GPD/FT
$t_1 = 6$ HR, $S_1 = 100$ FT., $t_2 = 48$ HR

$$3776 = \frac{264\,(300)}{S_2 - 100} \log \frac{48}{6} = \frac{264\,(300)}{S_2 - 100}\,(0.9)$$

$S_2 = 100 + 19 = 119$ FT.

GROUND ELEVATION = 59 FT.
DRAWDOWN ELEVATION = -6 FT.

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY JGY DATE 3-21-18 SUBJECT FISH HATCHERY SHEET NO 3 OF 4
CHKD BY [illegible] DATE [illegible] JOB NO 9011A-10

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

SPRAY NOZZLES

DESIGN FLOW: $Q = 300$ GPM

DISCHARGE THROUGH NOZZLE $q = 19.636 K d^2 h^{1/2}$

1. USE $K = 0.61$, $h = 23'$, $d = 1/2"$

$q = 19.636 (0.61) (0.50)^2 (23)^{1/2} = 14.36$ GPM/NOZZLE

NO. OF NOZZLES REQ'D $= 300/14.36 = 21$

USE 3 - 6" LATERALS W/ 7 NOZZLES EACH

2. USE $K = 0.61$, $h = 23'$, $d = 3/8"$

$q = 19.636 (0.61) (0.38)^2 (23)^{1/2} = 8.08$ GPM/NOZZLE

NO. OF NOZZLES REQ'D $= 38$

USE 3 - 6" LATERALS W/ 13 NOZZLES EACH

BY J.C.Y. DATE 3-6-80 SUBJECT C.O.E. - S.C. SHEET NO 4 OF 4
CHKD BY [illegible] DATE 3/13/80 F.H.N. HATCHERY JOB NO 90116-10

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

HEAD LOSS BETWEEN ELEVATED WATER TANK AND HATCHING JAR (USE C = 100)

A). 1/4" PLASTIC PIPE @ 0.26 GPM

PIPE LENGTH	10'
VALVE (HALF CLOSED)	10'
TEE	3'

$23' \times 5.22/100 = 1.20'$

SUDDEN ENLARGEMENT

$Q = 0.26$ GPM OR 58×10^{-4} CFS

$A = \pi (1/4/12/2)^2 = 3.41 \times 10^{-4}$ ft²

$V = Q/A = 1.7$ FPS, USE $D/d = 10$, $H_f = 0.06'$

B). 2" PIPE @ 5.28 GPM

TEE 1.4 x 20	36'
PIPE	10'
TEE	6'

$52' \times 0.17/100 = 0.09'$

C). 4" PIPE @ 60 GPM

TEE 6.8 x 10	68'
ELL 10.2 x 4	41'
VALVE (HALF CLOSED)	70'
PIPE	150'

$330' \times 0.477/100 = 1.57'$

ENTRANCE LOSS

$Q = 60$ GPM OR 0.13 CFS

$A = \pi (4/2/12)^2 = 0.09$ ft²

$V = 1.53$ FPS, $K = 0.78$, $H_f = 0.05'$

D). TOTAL HEAD LOSS = 2.97'

E) STATIC HEAD PROVIDED

SET BOTTOM OF WATER TANK 20' ABOVE THE FILL LINES TO JARS.

APPENDIX NO. "D"

ELECTRICAL COMPUTATIONS

INTERIOR ILLUMINATION

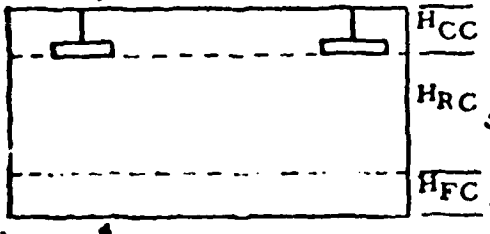
Job No. 90116-10

Room TOILET Ft. Candles Required 30

Length 5 x Width 4'8" = Area (A) 23.5 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20

Ceiling



Floor

$$CCR = \frac{5(H_{cc})(L+W)}{L \times W} = 0$$

$$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(5.5)(9.7)}{23.5} = 11.4$$

$$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = \frac{5(2.5)(9.7)}{23.5} = 5.2$$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%

P_{FC} Effective Reflectance (Floor Cavity) = 14%

) Table "B"

P_W Wall Reflectance = 50%

CU = .32

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC}) Table "C" or "D"

CU_F = .30, MF = .7

Fixture Type 1'x1' INC., Lamps/Fix 1, Watts/Fix 200

Lamp Type A-23 - INSIDE COATED, Lumens/Lamp 3830

$$\text{Total Lumens} = \frac{FC \times A}{CU \times MF} = \frac{30 \times 23.5}{.30 \times .7} = 3357$$

$$\text{No. Fixtures} = \frac{\text{Total Lumens}}{\text{Lumens/Lamp} \times \text{Lamps/Fix.}} = \frac{3357}{3830} = .88$$

Actual No. Fixtures Designed 1

$$\text{Revised FC} = \frac{\text{Total Fix.} \times \text{Lamps/Fix.} \times \text{Lumens/Lamp} \times CU \times MF}{\text{Area}} = 34$$

INTERIOR ILLUMINATION

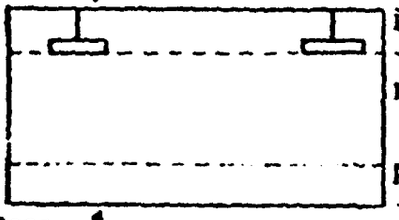
Job No. 90116-10

Room MECHANICAL ROOM Ft. Candles Required 30

Length 7'10" x Width 5'0" = Area (A) 39.4 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20

Ceiling



Floor

$$CCR = \frac{5(H_{cc})(L+W)}{L \times W} = 0$$

$$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(5.5)(12.9)}{39.4} = 9$$

$$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = \frac{5(2.5)(12.9)}{39.4} = 4$$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%

P_{FC} Effective Reflectance (Floor Cavity) = 11%

(Table "B")

P_W Wall Reflectance = 50%

CU = .36

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC} (Table "C" or "D")

CU_F = .3, MF = .7

Fixture Type 1'x4' RLM, Lamps/Fix 2, Watts/Fix 70

Lamp Type F40LW/RS/SS, Lumens/Lamp 3050

Total Lumens = $\frac{FC \times A}{CU \times MF} = \frac{30 \times 39.4}{.3 \times .7} = 5629$

No. Fixtures = $\frac{\text{Total Lumens}}{\text{Lumens/Lamp x Lamps/Fix.}} = \frac{5629}{6100} = .9$

Actual No. Fixtures Designed 1

Revised FC = $\frac{\text{Total Fix. x Lamps/Fix. x Lumens/Lamp x CU x MF}}{\text{Area}} = 33$

INTERIOR ILLUMINATION

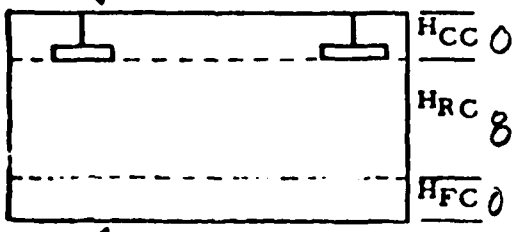
Job No. 90116-10

Room STORAGE Ft. Candles Required 10

Length 18 x Width 8 = Area (A) 144 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20

Ceiling



Floor

$$CCR = \frac{5(H_{CC})(L+W)}{L \times W} = 0$$

$$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(8)(26)}{144} = 7.2$$

$$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = 0$$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%

P_{FC} Effective Reflectance (Floor Cavity) = 20%

) Table "B"

P_W Wall Reflectance = 50%

CU = .43

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC}) Table "C" or "D"

CU_F = .43, MF = .7

Fixture Type 1'x4' RLM, Lamps/Fix 2, Watts/Fix 70

Lamp Type F40LW/RS/SS, Lumens/Lamp 3050

Total Lumens = $\frac{FC \times A}{CU \times MF} = \frac{10 \times 144}{.43 \times .7} = 4784$

No. Fixtures = $\frac{\text{Total Lumens}}{\text{Lumens/Lamp x Lamps/Fix.}} = \frac{4784}{4100} = .8$

Actual No. Fixtures Designed 1

Revised FC = $\frac{\text{Total Fix. x Lamps/Fix. x Lumens/Lamp x CU x MF}}{\text{Area}} = 12.5$

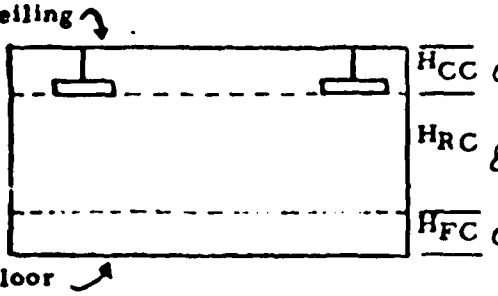
INTERIOR ILLUMINATION

Job No. 90116-10

Room STORAGE Ft. Candles Required 10

Length 18' 0" x Width 14'10" = Area (A) 267.7 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20



$CCR = \frac{5(H_{CC})(L+W)}{L \times W} = 0$

$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(8)(32.9)}{267.7} = 4.9$

$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = 0$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%

P_{FC} Effective Reflectance (Floor Cavity) = 20%

) Table "B"

P_W Wall Reflectance = 50%

CU = .57

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC}) Table "C" or "D"

CU_F = .57, MF = .7

Fixture Type 1'x4' RLM, Lamps/Fix 2, Watts/Fix 70

Lamp Type F40LW/RS/SS, Lumens/Lamp 3050

Total Lumens = $\frac{FC \times A}{CU \times MF} = \frac{10 \times 267.7}{.57 \times .7} = 6709$

No. Fixtures = $\frac{\text{Total Lumens}}{\text{Lumens/Lamp} \times \text{Lamps/Fix.}} = \frac{6709}{6100} = 1.09$

Actual No. Fixtures Designed 1

Revised FC = $\frac{\text{Total Fix.} \times \text{Lamps/Fix.} \times \text{Lumens/Lamp} \times CU \times MF}{\text{Area}} = 10$

INTERIOR ILLUMINATION

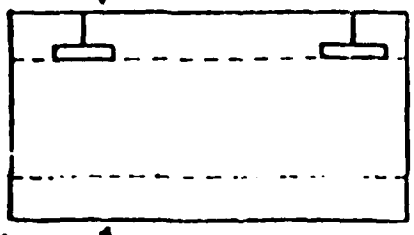
Job No. 90116-10

Room LABORATORY Ft. Candles Required 100

Length 18'2" x Width 11 = Area (A) 199.9 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20

Ceiling



Floor

$$CCR = \frac{5(H_{CC})(L+W)}{L \times W} = 0$$

$$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(4.5)(29.2)}{199.9} = 3.3$$

$$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = \frac{5(3.5)(29.2)}{199.9} = 2.6$$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%

P_{FC} Effective Reflectance (Floor Cavity) = 14%

(Table "B")

P_W Wall Reflectance = 50%

CU = .495

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC} (Table "C" or "D")

CU_F = .47, MF = .7

Fixture Type 2'x4' LAY. IN /W FLAT PRISMATIC LENS, Lamps/Fix 4, Watts/Fix 140

Lamp Type F40L.W/RS/SS, Lumens/Lamp 3050

$$\text{Total Lumens} = \frac{FC \times A}{CU \times MF} = \frac{100 \times 199.9}{.47 \times .7} = 60759.9$$

$$\text{No. Fixtures} = \frac{\text{Total Lumens}}{\text{Lumens/Lamp} \times \text{Lamps/Fix.}} = \frac{60759.9}{12200} = 5$$

Actual No. Fixtures Designed 6

$$\text{Revised FC} = \frac{\text{Total Fix.} \times \text{Lamps/Fix.} \times \text{Lumens/Lamp} \times CU \times MF}{\text{Area}} = 120$$

INTERIOR ILLUMINATION

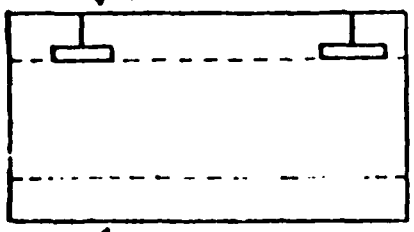
Job No. 90116-10

Room KITCHEN Ft. Candles Required 100

Length 18' 2" x Width 14' 10" = Area (A) 269.5 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20

Ceiling ↘



Floor ↗

$CCR = \frac{5(H_{CC})(L+W)}{L \times W} = 0$

$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(5.5)(33)}{269.5} = 3.4$

$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = \frac{5(2.5)(33)}{269.5} = 1.5$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%

P_{FC} Effective Reflectance (Floor Cavity) = 17%

) Table "B"

P_W Wall Reflectance = 50%

CU = .54

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC}) Table "C" or "D"

CU_F = .53, MF = .7

Fixture Type 2'x4' Lay-in W/ FLAT PRISMATIC LENS, Lamps/Fix 4, Watts/Fix 140

Lamp Type F40LW/RS/SS, Lumens/Lamp 3050

Total Lumens = $\frac{FC \times A}{CU \times MF} = \frac{100 \times 269.5}{.53 \times .7} = 72641.5$

No. Fixtures = $\frac{\text{Total Lumens}}{\text{Lumens/Lamp} \times \text{Lamps/Fix.}} = \frac{72641.5}{12200} = 6$

Actual No. Fixtures Designed 6

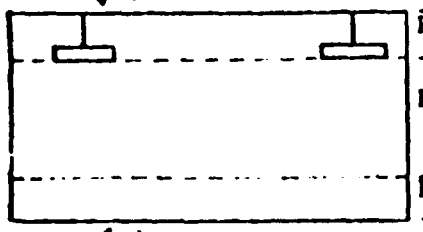
Revised FC = $\frac{\text{Total Fix.} \times \text{Lamps/Fix.} \times \text{Lumens/Lamp} \times CU \times MF}{\text{Area}} = 100$

INTERIOR ILLUMINATION Job No. 90116-10

Room HATCHING ROOM Ft. Candles Required 25

Length 32 x Width 29 = Area (A) 928 Sq. Ft.

Reflectance factors: Ceiling 80, Walls 50, Floor 20



$CCR = \frac{5(H_{CC})(L+W)}{L \times W} = 0$

$RCR = \frac{5(H_{RC})(L+W)}{L \times W} = \frac{5(5.5)(61)}{928} = 1.8$

$FCR = \frac{5(H_{FC})(L+W)}{L \times W} = \frac{5(2.5)(61)}{928} = .8$

P_{CC} Effective Reflectance (Ceiling Cavity) = 80%) Table "B"

P_{FC} Effective Reflectance (Floor Cavity) = 19%)

P_W Wall Reflectance = 50%

CU = .63

CU (final) = CU(20% floor) x Multiplier for Actual P_{FC}) Table "C" or "D"

CU_F = .62, MF = .7

Fixture Type 2'x4' - LAY-IN FLAT PRISMATIC LENS Lamps/Fix 4, Watts/Fix 140

Lamp Type F40LW/RS/SS, Lumens/Lamp 3050

Total Lumens = $\frac{FC \times A}{CU \times MF} = \frac{25 \times 928}{.62 \times .7} = 53456$

No. Fixtures = $\frac{\text{Total Lumens}}{\text{Lumens/Lamp x Lamps/Fix.}} = \frac{53456}{12200} = 4.4$

Actual No. Fixtures Designed 6

Revised FC = $\frac{\text{Total Fix. x Lamps/Fix. x Lumens/Lamp x CU x MF}}{\text{Area}} = 34$

BY JLS DATE 5/30 SUBJECT WELL PUMP #1 SHEET NO 1 OF 2
CHKD BY RJC DATE 5/30 JOB NO 90116-10
FEEDER TO WELL PUMP #1

BASCO ASSOCIATES
ARCHITECTS · ENGINEERS · PLANNERS

VOLT DROP CALCULATIONS

25 HP - 208 VOLT - 3 PH - 78.2 FLA - 442 LRA

DISTANCE = 200 FT. (WIRE SIZED FOR VOLT DROP AT START - NOT TO EXCEED 10% OF 208 VOLTS = 20.8 VOLTS)

CM	= CIRCULAR MILLS
I_L	= LINE CURRENT
d	= DISTANCE
10.7	= R OF CIR.-MILL-FT. (COPPER WIRE)
VD	= 10% OF 208 VOLTS

START

$$CM = \frac{2(I_L)(d)(10.7)}{VD} = \frac{2(442)(200)(10.7)}{20.8} = 90950 \text{ CM}$$

WIRE SIZE = # 1/0 @ 105600 CM

$$\text{ACTUAL START VD} = \frac{2(I_L)(d)(10.7)}{\text{CM OF WIRE SIZE USED}} = \frac{2(442)(200)(10.7)}{(105600)} = 17.9 \text{ V}$$

$$\% \text{ START VD} = \frac{\text{ACTUAL START VD}}{\text{SERVICE VOLTAGE}} \times 100 = \frac{(17.9)}{(208)} \times 100 = 8.6\ \%$$

RUN

$$\text{ACTUAL RUN VD} = \frac{2(I_L)(d)(10.7)}{\text{CM OF WIRE SIZE USED}} = \frac{2(78.2)(200)(10.7)}{(105600)} = 3.17 \text{ V}$$

$$\% \text{ RUN VD} = \frac{\text{ACTUAL RUN VD}}{\text{SERVICE VOLTAGE}} \times 100 = \frac{(3.17)}{208} \times 100 = 1.5\ \%$$

BY JLS DATE 5/30 SUBJECT WELL PUMP #2 SHEET NO 2 OF 2
CHKD BY RWP DATE 5/30 JOB NO 20116-10
FEEDER TO WELL PUMP # 2

BASCO ASSOCIATES
ARCHITECTS · ENGINEERS · PLANNERS

VOLT DROP CALCULATIONS

25 HP - 208 VOLT - 3 PH - 78.2 FLA - 442 LRA

DISTANCE = 2100 FT. (WIRE SIZED FOR VOLT DROP AT START - NOT TO EXCEED 10% OF _____ VOLTS = _____ VOLTS)

CM	= CIRCULAR MILLS
I_L	= LINE CURRENT
d	= DISTANCE
10.7	= R OF CIR.-MILL-FT. (COPPER WIRE)
VD	= 10% OF 208 VOLTS

START

$$CM = \frac{2(I_L)(d)(10.7)}{VD} = \frac{2(442)(2100)(10.7)}{20.8} = 954975 \text{ CM}$$

WIRE SIZE = #2 SEU 500MCM 1,000,000 CM

$$\text{ACTUAL START VD} = \frac{2(I_L)(d)(10.7)}{\text{CM OF WIRE SIZE USED}} = \frac{2(442)(2100)(10.7)}{(1,000,000)} = 19.9 \text{ V}$$

$$\% \text{ START VD} = \frac{\text{ACTUAL START VD} \times 100}{\text{SERVICE VOLTAGE}} = \frac{(19.9)}{(208)} \times 100 = 9.5 \%$$

RUN

$$\text{ACTUAL RUN VD} = \frac{2(I_L)(\quad)(10.7)}{\text{CM OF WIRE SIZE USED}} = \frac{2(78.2)(2100)(10.7)}{(1,000,000)} = 3.5 \text{ V}$$

$$\% \text{ RUN VD} = \frac{\text{ACTUAL RUN VD} \times 100}{\text{SERVICE VOLTAGE}} = \frac{(3.5)}{203} \times 100 = 1.7 \%$$

BY JLS DATE 1-1-20 SUBJECT SHORT CIRCUIT SHEET NO 1 OF 2

CHKD BY DAT 1-1-20 CALCULATION JOB NO 90116-10

POWER COMPANY TRANSFORMER SECONDARY SHORT CIRCUIT VALUE

SEE ONE LINE DIAGRAM ATTACHED

I_{SCA_P} = SHORT CIRCUIT CURRENT AT XFMR PRI.
I_{SCA_S} = SHORT CIRCUIT CURRENT AT XFMR SEC.
I_{SCA_1} = SHORT CIRCUIT CURRENT AT FAULT #1
I_{SCA_2} = SHORT CIRCUIT CURRENT AT FAULT #2
FLA = FULL LOAD AMPERES
Z = TRANSFORMER IMPEDENCE
E = LINE TO LINE VOLTAGE
C = CONSTANT VALUE FOR CONDUCTOR
L = LENGTH OF CIRCUIT
M = $1 \div (1+F)$
F = FAULT FACTOR
KVA = KILOVOLT-AMP RATING OF TRANSFORMER
V_P = VOLTAGE LINE TO LINE AT XFMR PRIMARY
V_S = VOLTAGE LINE TO LINE AT XFMR SECONDARY

$$F = \frac{I_{SCA_P} \times V_P \times 1.73 \times Z}{100{,}000 \times KVA} = \frac{500000 \times 12470 \times 1.73 \times 3.2}{100000 \times 112.5} = 3068$$

$$M = \frac{1}{1+F} = \frac{1}{1+3068} = .000326$$

$$I_{SCA_S} = \frac{V_P}{V_S} \times M \times I_{SCA_P} = \frac{12470}{208} \times .000326 \times 500000 = 9772 \text{ A}$$

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY JLS DATE 4-1-8 SUBJECT SHORT CIRCUIT SHEET NO 2 OF 2
CHKD BY RJP DATE 4-1-8 CALCULATION JOB NO 90116-10
LINE & LOAD SIDE OF MAIN SWITCH

I_{SCA_1} = LINE SIDE MAIN SWITCH
I_{SCA_2} = LOAD SIDE MAIN SWITCH

$$F = \frac{1.73 \times L \times I}{C \times E} = \frac{1.73 \times 50 \times 9772}{18100 \times 208} = .22$$

$$M = \frac{1}{1+F} = \frac{1}{1.18} = .82$$

MOTOR CONTRIBUTION = 4 (FLA x 90)

= 4 (200 x 65)

= 520

$I_{SCA_1} = I_{SCA_2} \times M$ + MOTOR CONTRIBUTION

= (9772 x .82) + 520 = 8533 A

I_{SCA_2} FROM FUSE CHART = 5700 A

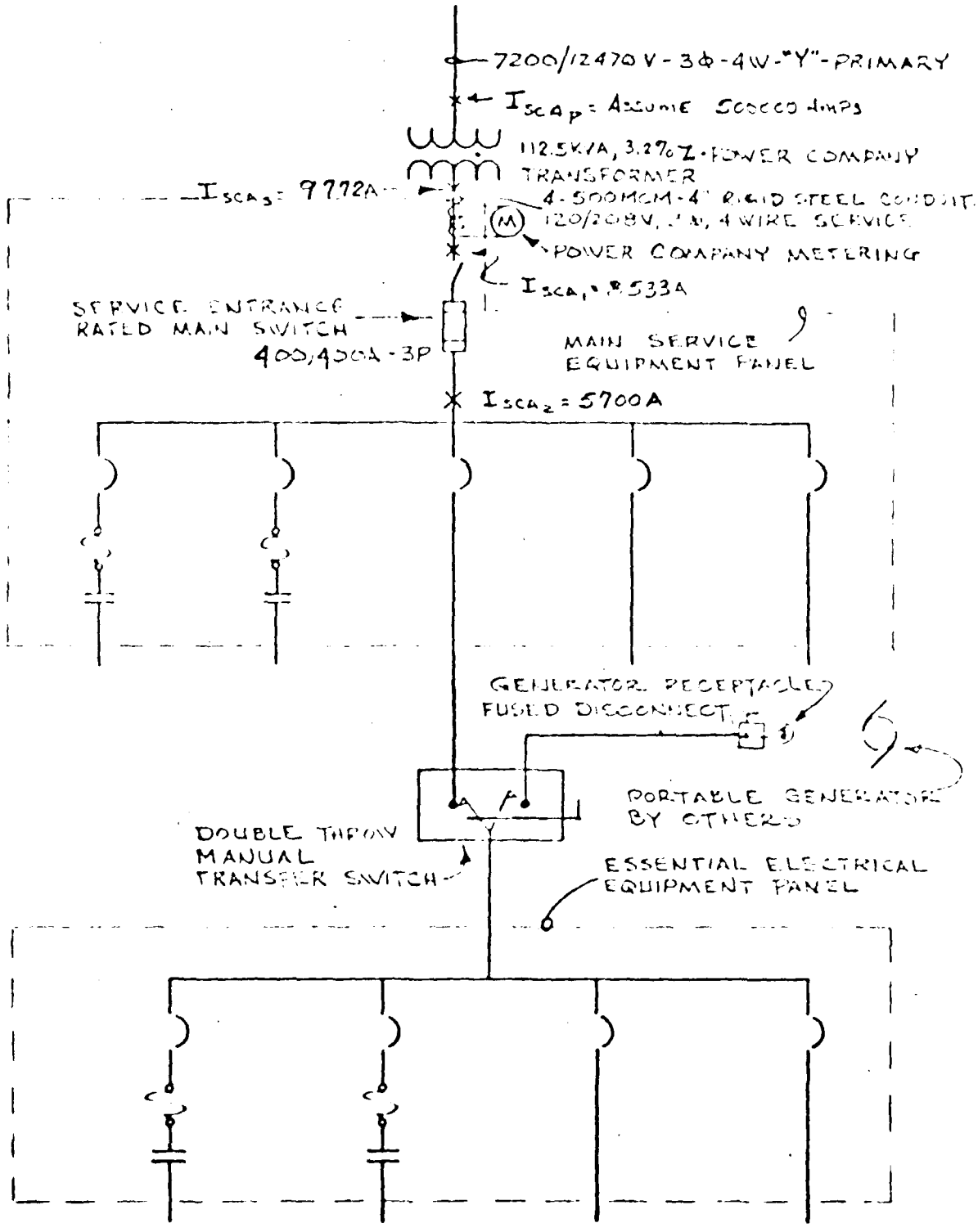
BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

BY _____ DATE _____ SUBJECT RISER _____ SHEET NO 1 OF 1

CHKD BY _____ DATE _____ JOB NO _____

PARTIAL ONE-LINE DIAGRAM

BUCHART - HORN
CONSULTING ENGINEERS AND PLANNERS

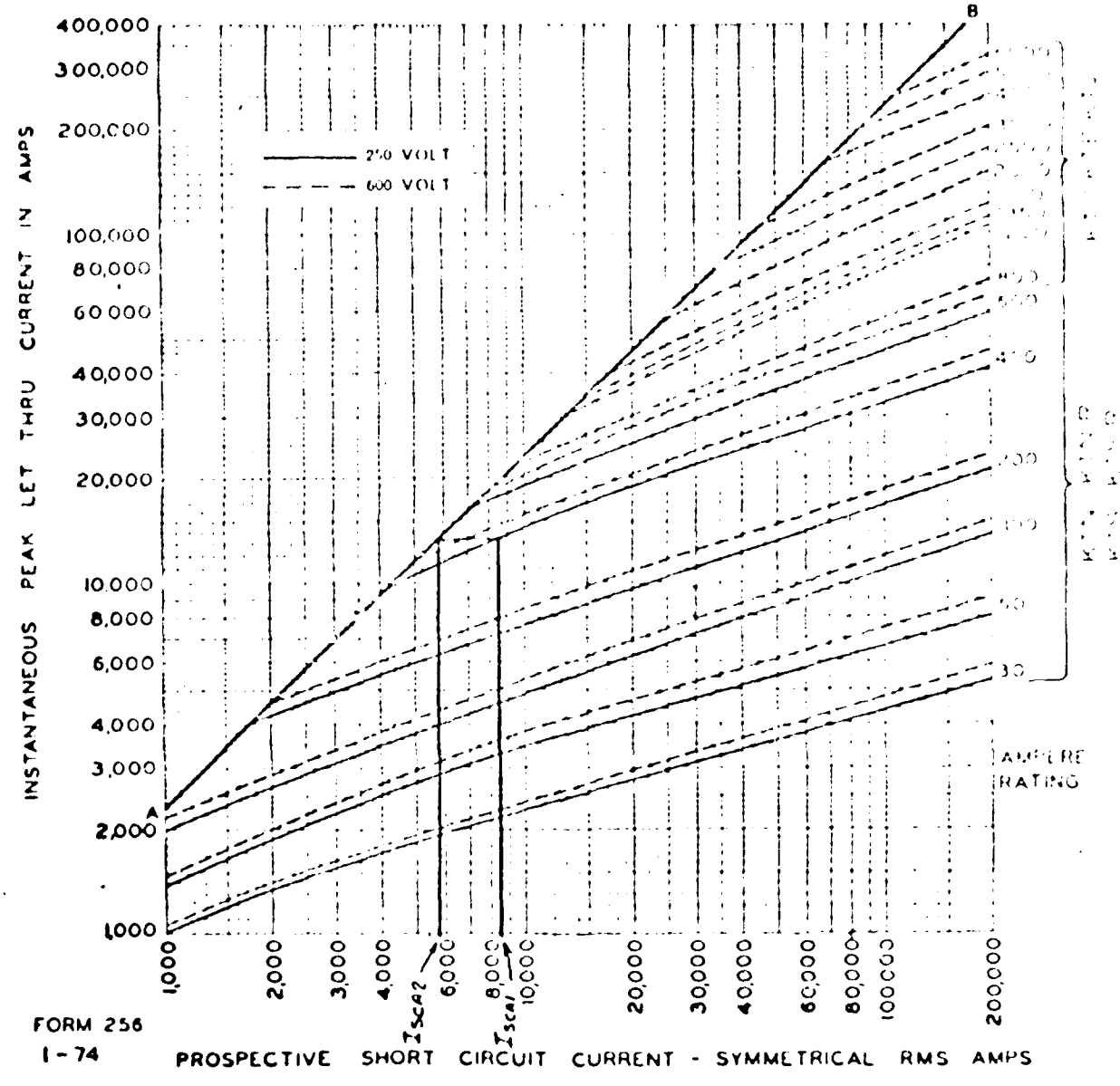


PARTIAL ONE LINE DIAGRAM

NO SCALE

DATA SECTION—CHART NO. 2

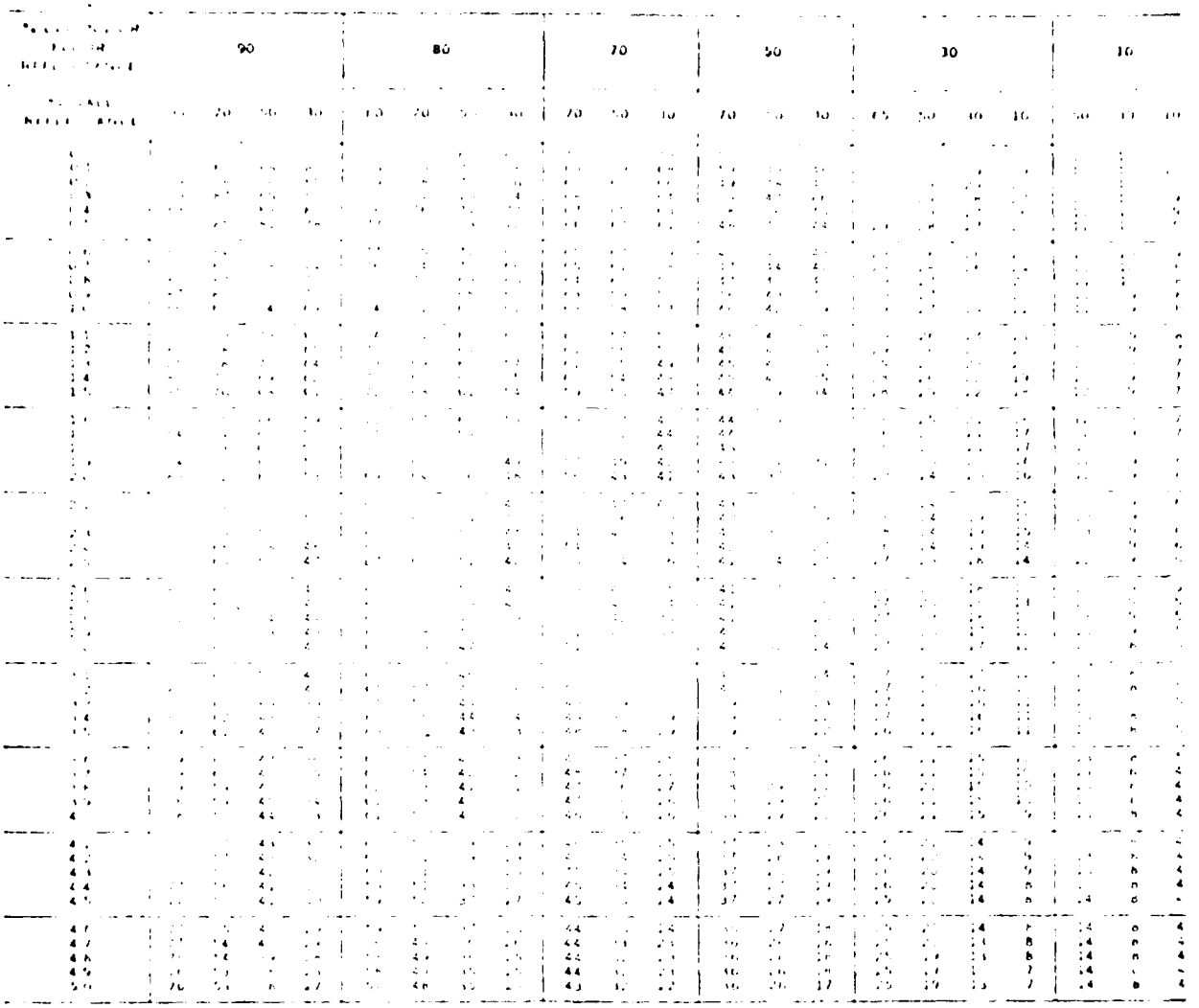
Current Limiting Effect of LIMITRON Fast-Acting Fuses
KTN, KTN-R (250 Volts a-c); KTS, KTS-R, KTU (600 Volts a-c)



FORM 256
1-74

TABLE B

PER CENT EFFECTIVE CEILING OR FLOOR CAVITY REFLECTANCE
FOR VARIOUS REFLECTANCE COMBINATIONS



reflectance values found will then be ρ_{cc} (effective ceiling cavity reflectance) and ρ_{fc} (effective floor cavity reflectance).

Step 3:

With the values of ρ_{cc} (previously found), ρ_w (wall reflectance), and ρ_{fc} the room cavity ratio (RCR) previously calculated, find the coefficient of utilization in the appropriate table for the luminaire under consideration. Note that since the table is now linear, linear interpolations can be made for exact cavity ratios or reflectance combinations.

Since the coefficient of utilization found will be for a 20% effective floor cavity reflectance, it will be necessary to correct for the ρ_{fc} as previously determined. This is done by reference to tables C or D to find a multiplier to be used in conjunction with the already determined coefficient of utilization.

CU final = CU (20% floor) x Multiplier for actual ρ_{fc}

Step 4:

Computation of footcandle level is performed using standard lumen method formula.

$$FC_{initial} = \frac{\text{No. of fixtures} \times \text{lamps/fixture} \times \text{lumens/lamp} \times CU}{\text{Area}}$$

If maintained illumination levels are to be calculated, the above formula should be modified by multiplying by a maintenance factor composed of factors to consider

TABLE C

MULTIPLYING FACTORS FOR 30 PER CENT EFFECTIVE FLOOR CAVITY REFLECTANCE (20 PER CENT = 1.00)

Effective Ceiling Cavity Reflectance	80				70				50			30			10		
Wall Reflectance	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
Room Cavity Ratio																	
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE D

MULTIPLYING FACTORS FOR [illegible] PER CENT EFFECTIVE FLOOR CAVITY REFLECTANCE (20 PER CENT = 1.00)

Effective Ceiling Cavity Reflectance	80				70				50			30			10		
Wall Reflectance	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
Room Cavity Ratio																	
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] predict de- [illegible] of [illegible] coefficient of utilization [illegible] to predict [illegible] service values of [illegible]

Example

A typical classroom [illegible] wide and 32' long and has a 12.6" ceiling height. Reflectances: Ceiling 80%, Walls 50%, Floor [illegible]. Luminaire No. 6500 REALITE II is to be used on 2.6" stems. Work plane is 2.0". Find the coefficient of utilization.

(1) Calculate cavity ratios as follows or look up in table of cavity ratios (Table A).

$$CCR = \frac{5 \times 2.6 \times (28 + 32)}{28 \times 32} = .84$$

$$RCR = \frac{5 \times [illegible] \times (28 + 32)}{28 \times 32} = 2.7$$

$$FCR = \frac{5 \times 2 \times (28 + 32)}{28 \times 32} = .67$$

(2) In table B, look up effective cavity reflectances for ceiling and floor cavities. ρ_{cc} for the ceiling cavity will be 68 while ρ_{fc} for the floor cavity will be 11.

(3) Knowing the room cavity ratio (RCR), it is now possible to find the coefficient of utilization for the No. 6500 luminaire in a room having an RCR of 2.7 and effective reflectances as follows:

$\rho_{cc} = 68\%$, $\rho_w = 50\%$, $\rho_{fc} = 20\%$

This C.U. = .56. Note that this C.U. is for an effective floor reflectance of 20% while the actual effective reflectance of the floor ρ_{fc} is 11%. To correct for this, locate the appropriate multiplier in table C for the RCR already calculated (2.7). It is .955 and is found by interpolating between the numbers for 50% and 70% ρ_{cc} and between RCR's of 2.0 and 3.0. Then:

$$C.U._{final} = .56 \times .955 = .53$$

(4) Illumination level can now be calculated if we know the number of units to be used and the lamp lumen rating.

$$F.C._{initial} = \frac{\text{No. of fixtures} \times \text{lamps/fixture} \times \text{lumens/lamp} \times C.U.}{\text{Area}}$$

APPENDIX NO. "F"

Hole No. T-71

DRILLING LOG	DIVISION: SOUTH ATLANTIC	INSTALLATION: ST. STEPHEN, S. C.	SHEET 1 OF 4 SHEETS

1 PROJECT: COOPER RIVER, BERKELEY N

2 LOCATION (Coordinates or Station): N 582,[illegible] E 2,224,490

3 DRILLING AGENCY: SAVANNAH DISTRICT

4 HOLE NO (As shown on drawing title and file number): T-71

5 NAME OF DRILLER: H. [illegible]

6 DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.

7 THICKNESS OF OVERBURDEN

8 DEPTH DRILLED INTO ROCK

9 TOTAL DEPTH OF HOLE: 51.0'

10 SIZE AND TYPE OF BIT: 3 7/8" [illegible]

11 DATUM FOR ELEVATION SHOWN (MSL or MLW): MSL

12 MANUFACTURER'S DESIGNATION OF DRILL: FAILING 314

13 TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0

14 TOTAL NUMBER CORE BOXES

15 ELEVATION GROUND WATER

16 DATE HOLE: STARTED 12 AUG 77; COMPLETED 13 AUG 77

17 ELEVATION TOP OF HOLE: ≈5.0

18 TOTAL CORE RECOVERY FOR BORING

19 SIGNATURE OF INSPECTOR: R. H. BIANCHI

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SILTY FINE SAND, BLACK, ORGANIC, MOIST.		1	W.T. 4.5' DATE 12 AUG 77 Depth to water during drilling
	2		WHITE TO TAN			W.T. 0.2' ABOVE GROUND 29 HOURS AFTER HOLE COMPLETED. RAINED ALL NIGHT AND MORNING.
	4				2	
	6		REDDISH BROWN SILTY SAND, COARSE TO MEDIUM GRAINED, WELL GRADED, COHESIONLESS. WET.			
	8					
	10					
			BLACK, ORGANIC		3	
	12		CONTINUED SHEET 2			

NOTE: Soils Tie.1 classified in accordance with the Unified Soil Classification System.

BLOWS PER FOOT
Numbers required to drive 1⅜" ID Splitspoon w/140 lb. hammer falling 30".

DRILLING LOG (Cont Sheet) 510' Hole No. T-71

PROJECT: COOPER RIVER REDIVERSION

INSTALLATION: ST. STEPHEN

SHEET 2 OF 4 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			SM- SILTY FINE SAND, BLACK, ORGANIC, MOIST.				2
							4
							2
	14				4		1
							2
							4
							4
	16						1
							3
			CORK GRAY, SILTY FINE SAND, DENSE, MOIST				22
					5	USE DRILLING MUD AT 18.0'	22
	18						30
							25
							11
							22
	20						14
							23
							25
							12
	22						9
							12
							17
							22
	24						22
							9
							15
			ABUNDANT LIGNITE PRESENT				25
	26				6	50/0.2'	50
			MEDIUM GRAY			SPLITSPOON REFUSAL 26.2'	
			CONTINUED ON SHEET 3				

BLOWS PER FOOT
Numbers required to drive 1⅜" ID Splitspoon w/140 lb. hammer falling 30".

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 51.0' | Hole No. T-71

PROJECT: DOCK'S RIVER AGGRIVERSION | INSTALLATION: ST. STEPHEN | SHEET 3 OF 4 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if not noted) g
			SM- SILTY FINE SAND, MEDIUM GRAY, SLICK DILATANCY, WET.			PULL 1 26.0'—31.0'
						RUN 5.0'
						REC 5.0'
	29			100		C.L. 0.0'
					BOX 1	
	31					PULL 2 31.0'—36.0'
						RUN 5.0'
						REC 5.0'
	33					C.L. 0.0'
				100		
	35					
			CORE LOSS			PULL 3 36.0'—41.0'
	37					RUN 5.0'
						REC 3.0'
					BOX 2	C.L. 5.0'
	39			0		
	41		SM- SAME AS ABOVE			PULL 4 41.0'—76.0'
						RUN 5.0'
				76		REC 3.8'
						C.L. 1.2'
	43		CONTINUED ON SHEET 4			

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE 51.0 | Hole No. I-71

PROJECT: COAST FLOOD PROTECTION | INSTALLATION: ST. STEPHEN | SHEET 4 OF 4 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SM- SILTY FINE SAND, MEDIUM GRAY, WET			PULL 4 CONTINUED
					Box 2	
	45		CORE LOSS			
			SM- SILTY FINE SAND, MEDIUM GREY, QUICK OCCASIONAL, WET.			PULL 5 46.0'– 51.0'
	47					RUN 5.0'
						REC 5.0'
						C.L. 0.0'
	49			100		
					Box 3	
0.0	51					PULL 6 51.0'– 56.0'
						RUN 5.0'
						REC 5.0'
	53					C.L. 0.0'
				100		
	55					
-5.0	56		BOTTOM OF HOLE 56.0'			

Hole No. FH-1

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: St. Stephen, SC	SHEET 1 OF 1 SHEETS
1 PROJECT: Cooper River Fish Hatchery		10 SIZE AND TYPE OF BIT: 1 3/8" ID Splitspoon	
2 LOCATION (Coordinates or Station): 6' South of Water Tower Stake		11 DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3 DRILLING AGENCY: Savannah District		12 MANUFACTURER'S DESIGNATION OF DRILL: CME 55	
4 HOLE NO (As shown on drawing title and file number): FH-1		13 TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6	UNDISTURBED 2
5 NAME OF DRILLER: P. Rountree		14 TOTAL NUMBER CORE BOXES: 0	
6 DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG FROM VERT.		15 ELEVATION GROUND WATER	
		16 DATE HOLE: STARTED 3 Feb 81	COMPLETED 3 Feb 81
7 THICKNESS OF OVERBURDEN: 21.0'		17 ELEVATION TOP OF HOLE: +61.3'	
8 DEPTH DRILLED INTO ROCK: 0.0'		18 TOTAL CORE RECOVERY FOR BORING: %	
9 TOTAL DEPTH OF HOLE: 21.0'		19 SIGNATURE OF INSPECTOR: M. Delano	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO JAR	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	BLOWS
+61.3	0						
			SM - Brown, fine, silty sand with small, fat, clay seam		1	W. T. 16.3'	5
+59.3			CL - Tan to brown, slighty sandy, lean clay		2	Date 3 Feb 81 Depth to water during drilling	6
	5						13
						W. T. 15.5' Water table reading 24 hrs. after hole completed.	19
+53.3							17
			SC - Tan to brown, fine to coarse, clayey sand		3		14
+51.8			SM - Yellow-brown, medium to coarse, silty sand		4		12
	10						13
						NOTE: Undisturbed sample #1 from 3.0' to 5.0' UD-2 from 15.0' to 17.0'	19
							16
+45.8	15		SM/CH - Lamine of fine orange, silty sand and gray, fat, plastic clay		5		8
							18
							15
	20						
+40.3					6		8
			Bottom of Hole 21.0'			BLOWS PER FOOT:	
			NOTE: Soils field classified in accordance with the Unified Soil Classification Systems.			Number required to drive 1 3/8" ID splitspoon w/140 lb. hammer falling 30".	

Hole No. FH-2

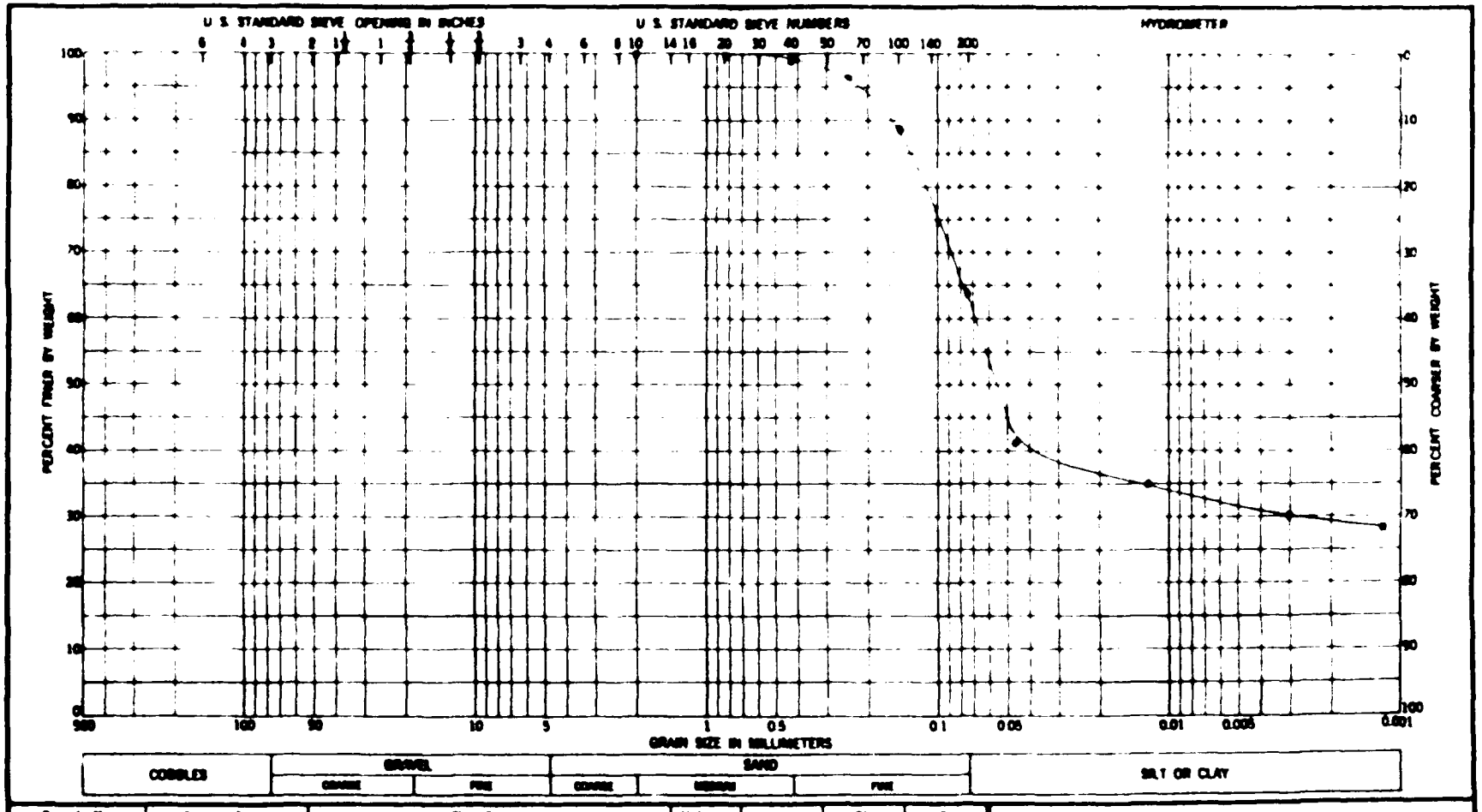
DRILLING LOG	DIVISION South Atlantic	INSTALLATION St. Stephens, S. C.	SHEET 1 OF 1 SHEETS

1 PROJECT: Cooper River Fish Hatchery	10 SIZE AND TYPE OF BIT
2 LOCATION (Coordinates or Station): 6' north of water tower stake	11 DATUM FOR ELEVATION SHOWN (USGS or MSL): MSL
3 DRILLING AGENCY: Savannah District	12 MANUFACTURER'S DESIGNATION OF DRILL: CME 55
4 HOLE NO (As shown on drawing title and file number): FH-2	13 TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6 / UNDISTURBED 0
5 NAME OF DRILLER: P. Rountree	14 TOTAL NUMBER CORE BOXES: 0
6 DIRECTION OF HOLE: X VERTICAL ___ INCLINED ___ DEG FROM VERT	15 ELEVATION GROUND WATER: +45.2'
7 THICKNESS OF OVERBURDEN: 51.0'	16 DATE HOLE: STARTED 3 Feb 81 / COMPLETED 3 Feb 81
8 DEPTH DRILLED INTO ROCK: 0.0'	17 ELEVATION TOP OF HOLE: +61.3'
9 TOTAL DEPTH OF HOLE: 51.0'	18 TOTAL CORE RECOVERY FOR BORING: %
	19 SIGNATURE OF INSPECTOR: M. Delano

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
+61.3	0						
			SM - Orange to brown, fine silty sand		1	W.T. 16.1' Date 3 Feb 81 Depth to water during drilling	5
+57.3	4						8
			CL - Orange to brown, sandy lean clay		2	W.T. 15.3' Water Table reading 24 hrs. after hole completed.	22
							44
							39
+51.3	10						31
			SC - Yellow, brown, and orange, fine to coarse clayey sand		3	BLOWS PER FOOT: Number required to drive 1 3/8" D splitspoon w/40 lb. hammer falling 30".	24
+48.3	13						18
			SM - Yellowish brown, fine to coarse silty sand		4		19
						NOTE: Soils field classified in accordance with the Unified Soil Classification Systems.	18
+44.3	17						14
			SM/CH - Laminae of fine, brown, silty sand and gray, fat, plastic clay		5		17
							15
+41.3	20				6		7
			Bottom of Boring 21'				

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO.
Req. No.



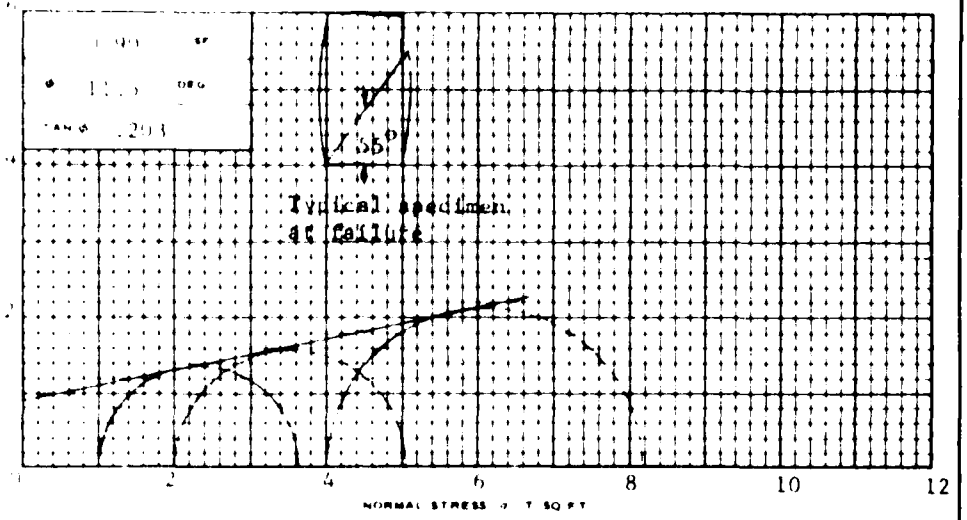
Sample No.	Elev. or Depth	Classification	Nat. w %	LL	PL	PI
UD-1	T.O.H. 61.3	Red sandy lean clay (CL)	21.9	49	23	26
	3.0-5.0'					

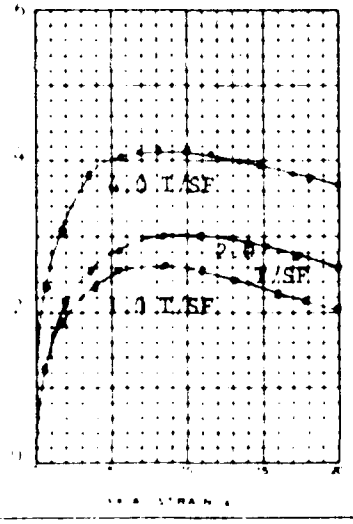
GRADATION CURVES

Project: Cooper River Fish Hatchery
Lab No. 235 2261 Top (Q Test)
Area: Water Tower
Boring No.: FH-1, Sample UD-1
Date: 27 March 1981

ENG FORM 1 MAY 68 2087

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30060





SPECIMEN NO		1	2	3
AFTER SHEAR — WATER CONTENT %	w_f	21.8	23.1	20.8
AFTER SHEAR — DRY DENSITY LB/CU FT	γ_{d_f}	101.6	100.7	103.4
AFTER SHEAR — SATURATION %	S_f	88.4	91.9	88.1
AFTER SHEAR — VOID RATIO	e_f	.672	.685	.642
BEFORE SHEAR — WATER CONTENT %	w_c	--	--	--
BEFORE SHEAR — DRY DENSITY LB/CU FT	γ_d	--	--	--
BEFORE SHEAR — SATURATION %	S_c	--	--	--
BEFORE SHEAR — VOID RATIO	e_c	--	--	--
BEFORE SHEAR — FINAL BACK PRESSURE T/SQ FT	u_b	--	--	--
MINOR PRINCIPAL STRESS T/SQ FT	σ_3	1.00	2.00	4.00
MAXIMUM DEVIATION STRESS T/SQ FT	$(\sigma_1-\sigma_3)_{max}$	2.63	3.03	4.18
AT % STRAIN	ε_f	11	13	11
ULTIMATE DEVIATION STRESS T/SQ FT	$(\sigma_1-\sigma_3)_{ult}$	2.30	2.87	3.90
INITIAL DIAMETER IN	D_o	1.38	1.38	1.38
INITIAL HEIGHT IN	H_o	3.08	3.08	3.08

RATE OF STRAIN .75 %/min TEST

SOIL DESCRIPTION Red & tan sandy lean clay (CL)

LL 49 PL 23 PI 26 Gs 2.72 TYPE OF SPECIMEN Undisturbed TYPE OF TEST Q

REMARKS

See Gradation Curve on ENG Form 2087.

PROJECT COOPER RIVER FISH HATCHERY

AREA: Water Tower

BORING NO. FH-1 SAMPLE NO. UD-1

DEPTH IN FT. 3.0'-5.0'/T.Q.H. 61.3

LABORATORY SADEN-FL DATE 30 March 1981

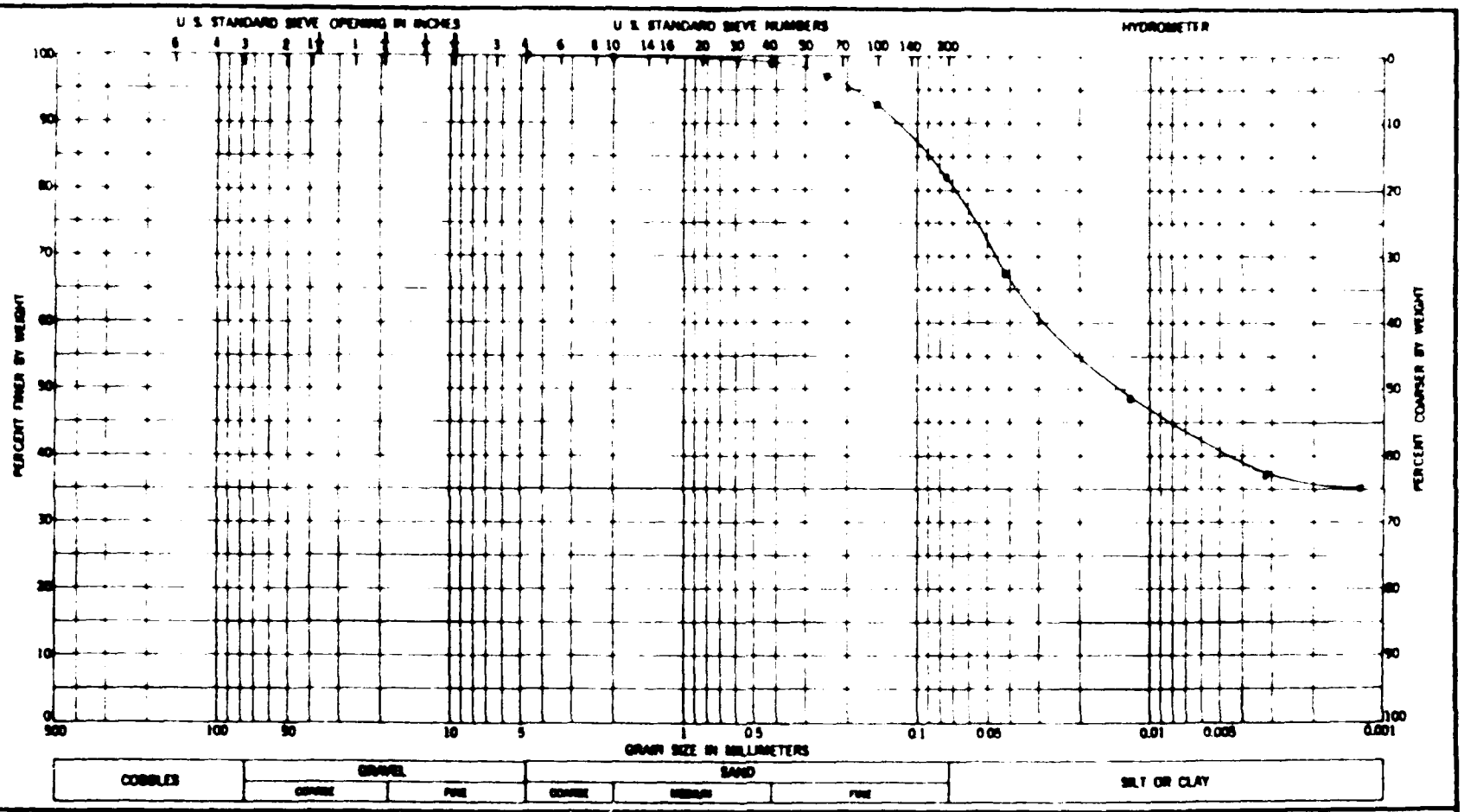
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION OBSOLETE TRANSLUCENT (EM 1110-2-1906)

LAB. NO. 235/2261 TOP

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. ..
Req. No. ..



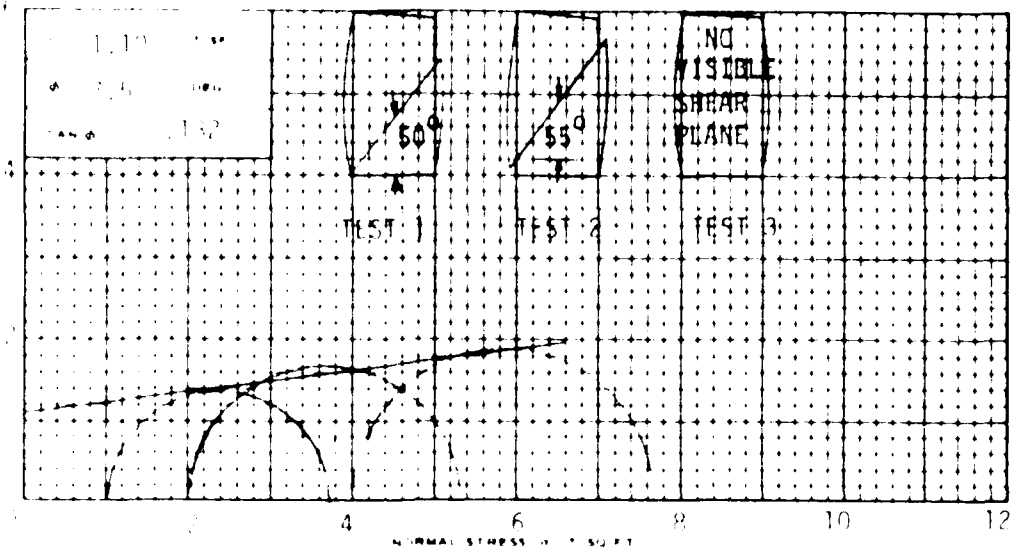
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
JD-1	TOH 61.3	Red & tan fat clay (CH)	34.6	51	23	28
	3.0'-5.0'	w/a little sand				

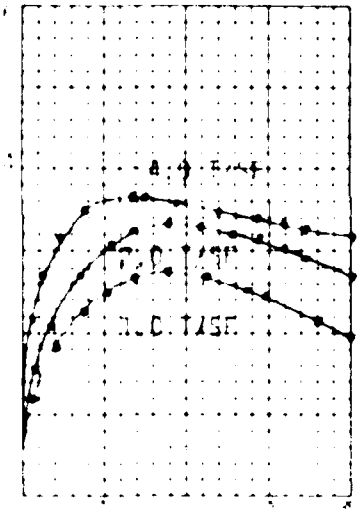
GRADATION CURVES

Project: COOPER RIVER FISH HATCHERY
Lab. No. 235/2261 Bot *
Area: Water Tower
Boring No.: FH-1, Sample JD-1
Date: 30 March 1981

ENG FORM 1 MAY 68 2087

*CDD, CONSOL, Q TESTS





	1	2	3	
WATER CONTENT %	26.8	26.8	25.7	
DRY DENSITY	97.9	98.2	98.8	
SATURATION %	99.8	99.4	96.9	
VOID RATIO	.740	.736	.724	
WATER CONTENT %	--	--	--	
DRY DENSITY	--	--	--	
B VALUE	--	--	--	
SATURATION %	--	--	--	
VOID RATIO	--	--	--	
RATE OF STRAIN %	--	--	--	
MINOR PRINCIPAL STRESS, LB/SQ FT	1.00	2.00	4.00	
MAXIMUM OBLIQUITY	2.74	3.32	3.61	
	12	12	12	
MAJOR PRINCIPAL STRESS, LB/SQ FT	2.40	3.35	3.35	
INITIAL DIAMETER, IN	1.38	1.38	1.38	
INITIAL HEIGHT, IN	3.09	3.08	3.08	

Brn & tan fat clay (CH) w/a little sand

2.73 ... undisturbed

REMARKS

See Gradation Curve on ENG Form 2087.

COOPER RIVER FISH HATCHERY

AREA: Water Tower

HOLE NO. FH-1 SAMPLE NO. UD-1

DEPTH 3.0'-5.0' ELEV. 61.3

LAB. NO. SADEN-FL DATE 30 March 1981

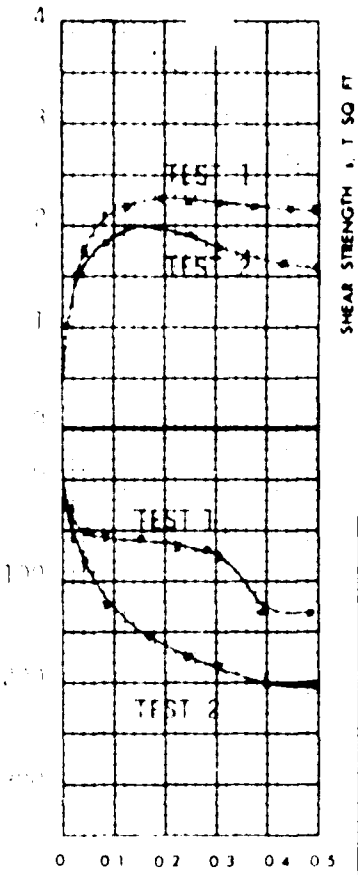
TRIAXIAL COMPRESSION TEST REPORT

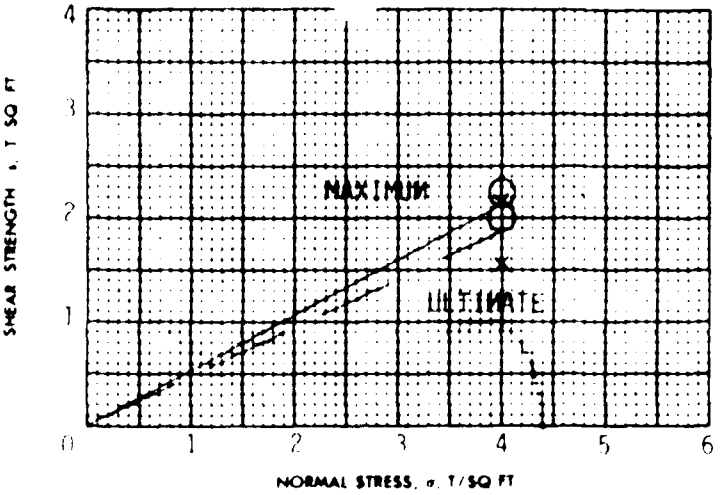
TRANSLUCENT EM 1110-2-1906

LAB. NO. 235/2261 Bot.

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY,
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA. 30061

WORK ORDER NO. [illegible]
REQ. NO. [illegible]





SHEAR STRENGTH PARAMETERS

	Maximum	Ultimate
φ	[illegible]	[illegible]
TAN φ	[illegible]	.466
	[illegible]	T SQ FT

☐ CONTROLLED STRESS
☒ CONTROLLED STRAIN

TEST NO		1	2		
INITIAL — WATER CONTENT	w_o	22.9 %	24.2 %	%	%
INITIAL — VOID RATIO	e_o	.723	.751		
INITIAL — SATURATION	S_o	86.5 %	87.9 %	%	%
INITIAL — DRY DENSITY LB/CU FT	γ_d	98.9	97.3		
VOID RATIO AFTER CONSOLIDATION	e_c	.610	.643		
TIME FOR 50 PERCENT CONSOLIDATION MIN	t_{50}	1	<1		
FINAL — WATER CONTENT	w_f	20.7 %	20.9 %	%	%
FINAL — VOID RATIO	e_f	.565	.570		
FINAL — SATURATION	S_f	100.0 %	100.0 %	%	%
NORMAL STRESS T SQ FT	σ	4.0	4.0		
MAXIMUM SHEAR STRESS T SQ FT	τ_{max}	2.26	2.00		
ACTUAL TIME TO FAILURE MIN	t_f	180	120		
RATE OF STRAIN IN MIN		.001	.001		
ULTIMATE SHEAR STRESS T SQ FT	τ_u	2.17	1.55		

TYPE OF SPECIMEN [illegible] 3.00 IN SQUARE 0.49 IN THICK

CLASSIFICATION Red & tan fat clay (CH) w/a little sand

LL [illegible] PL [illegible] PI [illegible] D_{10} < .001mm G_s 2.73

REMARKS

See Gradation Curve on ENG Form [illegible].

PROJECT COOPER RIVER FISH HATCHERY

LAB. NO. 235/2261 BOT

AREA Water Tower

BORING NO FH-1 SAMPLE NO UD-1

DEPTH 3.0'-5.0' DATE 30 March 1981

EL T.O.H. 61.3'

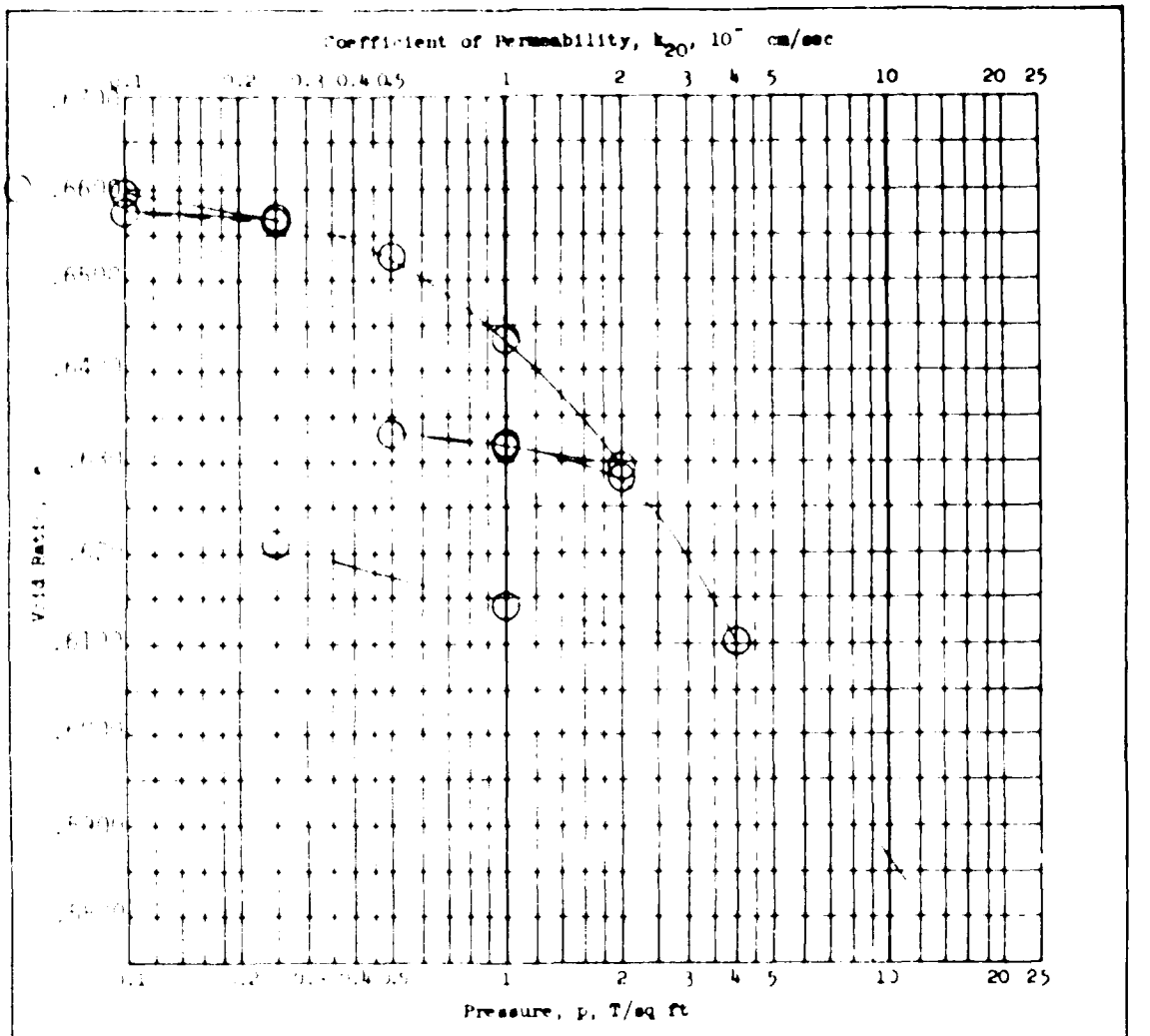
DIRECT SHEAR TEST REPORT

ENG FORM 2092 1 JUN 66 (EM [illegible] 2 [illegible]) PREVIOUS EDITIONS ARE OBSOLETE GPO [illegible]

PLATE IX-3

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE, MARIETTA, GA 30061

WORK ORDER NO
Req. No.



Type of Specimen	Undisturbed		
Diam 3.99 in.	Ht 1.[illegible] in.		
Overburden Pressure, p_o	T/sq ft		
Preconsol. Pressure, p_c	T/sq ft		
Compression Index, C_c			
Classification	Wet V fan Fat Clay (CH) w/a little Sand		
LL 53	G_s [illegible]		
PL 23	% < .001 mm		

Before Test		After Test	
Water Content, w_o	21.3 %	w_f	22.9 %
Void Ratio, e_o	.661	e_f	.626
Saturation, S_o	87.8 %	S_f	100.0 %
Dry Density, γ_d	[illegible] lb/ft^3		
k_{20} at e_o =	x 10^{-} cm/sec		

Project COPPER RIVER FISH HATCHERY

Lab. No. 235/2261

Area Water Tower

Boring No. FH-1 Sample No. UD-1

Depth 3.0'-5.0' Date 30 March 1981

El [illegible] M.H. 61.3'

CONSOLIDATION TEST REPORT

Remarks 1. See Gradation Curve on ENG Form 2087.

2. Specimen flooded throughout test.

ENG FORM 2090 MAY 65 PREVIOUS EDITIONS ARE OBSOLETE

ISH HATCHERY

WATER TOWER

BEARING CAPACITY CALCULATIONS rsm

8 April 81

General Bearing Capacity Equation modified for eccentric loading ... SE 4

A

C = 1.8 Ksf ϕ = 11.5° Tan ϕ = 0.203 δ = 123.7#/ft

B = 16' L = 16' N_c = 9.13 N_q = 2.92 N_γ = 0.64

B' = 13.46 L' = 13.46

Wind load (H) = 6.42 V = bending moment load + W_L + W_S + W_{Conc} = 154.6 (766 + 11.4 + 55.1)

$q_{ult} = N_c s_c d_c i_c g_c b_c + \bar{q} N_q s_q d_q i_q g_q b_q + \frac{1}{2} \gamma B N_\gamma s_\gamma d_\gamma i_\gamma g_\gamma b_\gamma$

C 1.8 ksf

N_c 9.13

$s_c = 1 + \frac{N_q B}{N_c L} = 1 + \frac{2.92}{9.13} = 1.32$

$d_c = 1 + 0.4 \frac{D}{B} = 1 + (0.4)\left(\frac{1.67}{13.46}\right) = 1.05$

$i_c = i_q - \frac{(1 - i_q)}{(N_q - 1)} = 0.99 - \left(\frac{1 - 0.99}{2.92 - 1}\right) = 0.98$

$i_q = \left(1 - \frac{0.5H}{V + A_f c \cot\phi}\right)^5 = \left(1 - \frac{0.5(6.42)}{154.6 + (13.46)^2(1.8)\left(\frac{1}{\tan 11.5}\right)}\right)^5 =$

i_q = 0.99

$g_c = 1 - \frac{i}{147} = 1$

$b_c = 1 - \frac{\eta}{147} = 1$

FISH HATCHERY

WATER TOWER

BEARING CAPACITY CALCULATIONS

APRIL 81

$\bar{q} = \gamma D = 123.7(1.67) = 206.6 = 0.2066$ K/SF

$N_q = 2.92$

$s_q = 1 + \left(\frac{B'}{L'}\right)\tan 115° = 1.20$

$d_q = 1 + 2\tan\phi(1-\sin\phi)^2\frac{D}{B} = 1 + 2(.2)(1-.2)^2\left(\frac{1.67}{13.46}\right) = 1.03$

$i_q = 0.99$ (see calculations on page 1)

$g_q = g_\delta = (1-0.5\tan\psi°)^5 = 1$

$b_q = \exp(-2\eta\tan\phi) = 1$

$\gamma = 0.1237$ K/cf

$B = 13.46$

$N_\gamma = 0.64$

$s_\gamma = 1 - 0.4\frac{B'}{L'} = 0.6$

$d_\gamma = 1.0$

$i_\gamma = \left(1 - \frac{0.7H}{V + A_f c\cot\phi}\right)^5 = \left(1 - \frac{0.7(6.42)}{1546 + (13.46)^2(1.8)\left(\frac{1}{\tan 115°}\right)}\right)^5$

$i_\gamma = 0.99$

$g_\delta = (1-0.5\tan\psi°)^5 = 1$

$b_\gamma = \exp(-1.7\eta\tan\phi) = 1$

$$q_{ult} = 1.8(9.13)(\underset{22.32}{11.32})(1.05)(0.98)(1)(1) + (0.2066)(29.2)(1.20)(1.03)(0.99)(1)(1) + \underset{0.74}{}$$

$$0.5(0.1237)(0.64)(\underset{0.32}{13.46})(0.6)(1)(0.99)(1)(1) = 23.38$$

$$q_a = \frac{q_u}{4} = 5.8 \text{ Ksf}$$

FISH HATCHERY

WATER TOWER 3

BEARING CAPACITY CALCULATIONS csm

8 Apr. 81

B. $C = 2.2$ ksf $\phi = 7.5°$ $\tan\phi = 0.132$ $\gamma = .124$ K/cf

$B = 16'$ ($B' = 13.46$) $L = 16'$ ($L' = 13.46$)

$N_c = 7.42$ $N_q = 2.05$ $N_\gamma = 0.25$

H = Wind Load = 6.42K V = 154.6 K (See Sheet 1)

$c = 2.2$

$N_c = 7.42$

$S_c = 1 + \frac{N_q B'}{N_c L'} = 1 + \frac{2.05}{7.42} = 1.28$

$d_c = 1 + 0.4 \frac{D}{B} = 1 + 0.4\left(\frac{1.67}{13.46}\right) = 1.05$

$\lambda_c = \lambda_q - \frac{(1-\lambda_q)}{N_q - 1} = 0.99 - \frac{(1-0.99)}{(2.05-1)} = 0.98$

$\lambda_q = \left(1 - \frac{0.5H}{V + A_f C \cot\phi}\right)^5 = \left(1 - \frac{0.5(6.42)}{154.6 + (13.46)^2(2.2)\left(\frac{1}{\tan 25°}\right)}\right)^5$

$\lambda_q = 0.99$

$g_c = i - \psi/147° = 1.0$

$b_c = \eta°/147° = 1.0$

$\gamma = 0.124$

$B = 13.46$

$N_\gamma = 0.25$

$S_\gamma = 1 - 0.4 \frac{B'}{L'} = 0.6$

$d_\gamma = 1.0$

$\lambda_\gamma = \left(1 - \frac{0.7H}{V + A_f C \cot\phi}\right)^5 = \left(1 - \frac{0.7(6.42)}{154.6 + (13.46)^2(2.2)\left(\frac{1}{\tan\phi}\right)}\right)^5 = 0.99$

$g_\gamma = (1 - 0.5\tan\eta°)^5 = 1$

$b_\gamma = \exp(2\eta\tan\phi) = 1$

FISH HATCHERY

WATER TOWER

BEARING CAPACITY CALCULATIONS

cam

8 April 81

$\bar{q} = \gamma D = 0.124(1.67) = 0.207$

$N_q = 2.05$

$s_q = 1 + \frac{B'}{L} \tan\phi = 1.13$

$d_q = 1 + 2\tan\phi(1-\sin\phi)^2 \frac{D}{B} = 1 + 2\tan\phi(1-\sin\phi)^2 \frac{1.67}{13.46} = 1.02$ (0.756)

$i_q = 0.99$ (See calculations on page 3)

$g_q = (1 - 0.5\tan\gamma)^5 = 1$

$b_q = \exp(-2\eta\tan\phi) = 1$

$q_u = 2(7.42)(1.28)(1.05)(0.98)(1)(1) + (0.207)(2.05)(1.13)(1.02)(0.99)(1)(1)$ (21.50) (0.48)

$0.5(0.124)(13.46)(0.25)(0.6)(1)(0.99)(1)(1) = 22.1$ (0.12)

$q_a = \frac{22.1}{4} = 5.52$

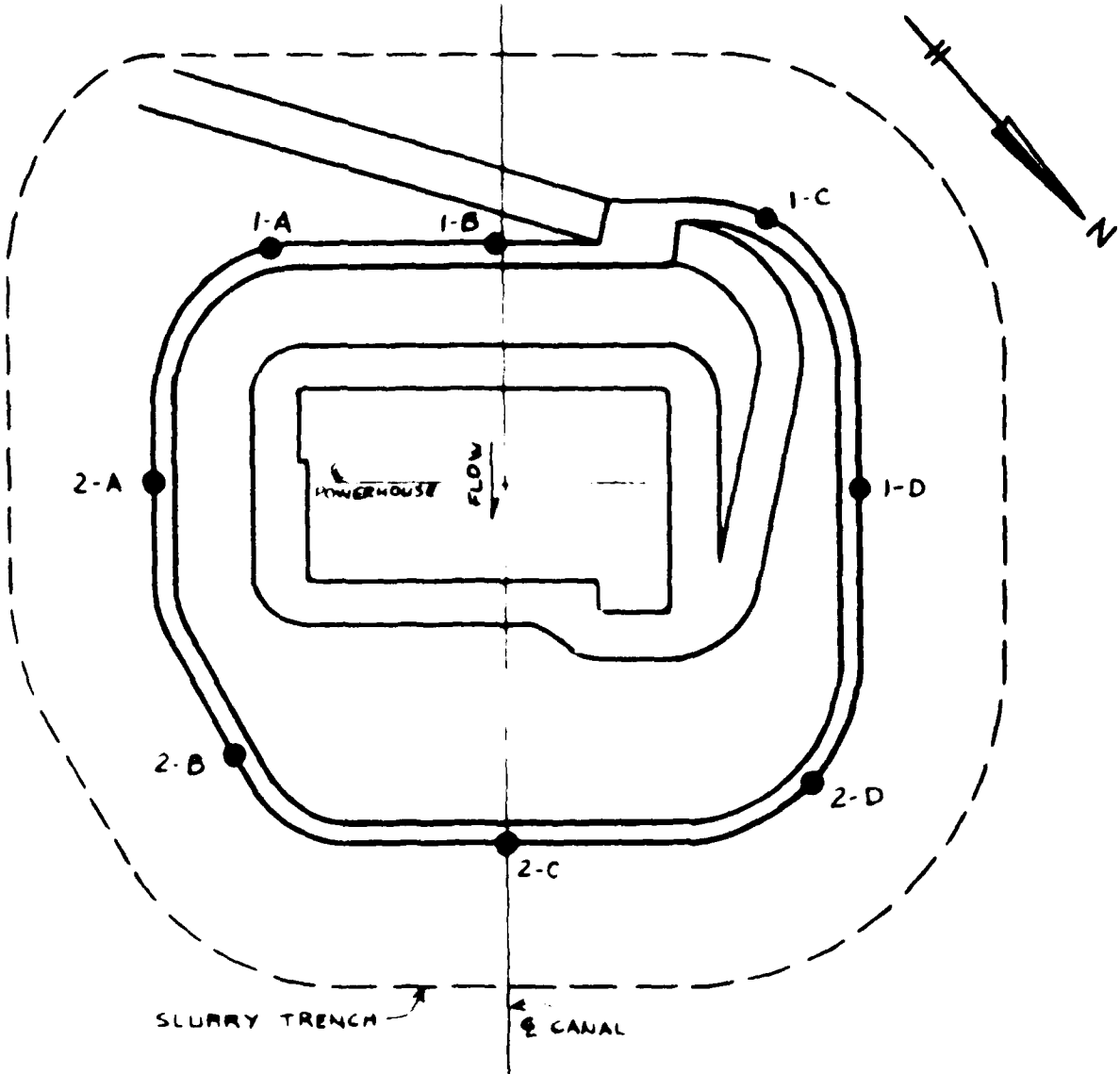
Use $q_a = 2.5$ T/SF

APPENDIX NO. "F"

RESULTS OF WATER QUALITY TESTING

WATER QUALITY TEST RESULTS

1. Tests were made on various dewatering wells in the powerhouse area which is approximately 900 feet from the proposed hatchery site. Part of the samples were taken from individual wells and others were taken from a manifold which drew a composite sample of all eight wells. See sketch on next page for well locations.



DEEP DE-WATERING WELLS
NUMBERING SYSTEM

PARKER LABORATORY, INC.

40 BROAD STREET
P. O. BOX 791
CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 35168

Composite sample

Date : July 28, 1980

Water sample submitted by : US Corps of Engineers, marked: dewatering well at power house, St. Stephen, S. C., sample #1, June 12, 1980

		PARTS PER MILLION
Turbidity	(N.T.U.)	.70
Color		5
Chloride	(Cl)	10
Total Alkalinity	(CaC03)	142
Carbonate alkalinity	(CaC03)	00
Bicarbonate Alkalinity	(CaC03)	142
Hardness	(CaC03)	130
Free Carbon Dioxide	(C02)	4
Iron	(Fe)	.02
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	.00
Silica	(Si02)	16
Calcium	(Ca)	50.4
Magnesium	(Mg)	1.0
Bicarbonate	(HC03)	173
Sulfate	(S04)	1
Carbonate	(C03)	.00
Fluoride	(F)	.10
Sodium & Potassium as	(Na)	11.90
pH value		7.90
Total dissolved solids		246
Specific conductance @ 25° C.		320

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.

To: US Corp. Engnrs.
Box 919
Chas., SC 29402
ATTN: MR G.H. FRANKLIN

PARKER LABORATORY, INC.

40 BROAD STREET
P. O. BOX 791
CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 35567

Composite sample

Date : July 28, 1980

Water sample submitted by : US Corp of Engineers; marked: dewatering well at power house, St. Stephen, SC, sample #2, June 12, 1980.

		PARTS PER MILLION
Turbidity	(N.T.U.)	.70
Color		5
Chloride	(Cl)	10
Total Alkalinity	(CaC03)	143
Carbonate alkalinity	(CaC03)	00
Bicarbonate Alkalinity	(CaC03)	143
Hardness	(CaC03)	130
Free Carbon Dioxide	(C02)	3
Iron	(Fe)	.02
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	.00
Silica	(Si02)	16
Calcium	(Ca)	50.4
Magnesium	(Mg)	1.0
Bicarbonate	(HC03)	174
Sulfate	(S04)	1
Carbonate	(C03)	.00
Fluoride	(F)	.10
Sodium & Potassium as	(Na)	11.90
pH value		8.00
Total dissolved solids		247
Specific conductance @ 25° C.		320

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.

To: US Corp. Engnr.
Box 919
Chas., SC 29402
ATTN: MR G.H. FRANKLIN

PARKER LABORATORY, INC.

40 BROAD STREET

P. O. BOX 791

CHARLESTON, SOUTH CAROLINA 29402

Analysis number: [illegible]

COMPOSITE SAMPLE

Date : [illegible], 1980

Water sample submitted by : U.S. Corps of Engineers, marked: dewatering well at power house, St. Stephen, SC, sample #1, July 23, 1980.

		PARTS PER MILLION
Turbidity	(N.T.U.)	1.60
Color		5
Chloride	(Cl)	6
Total Alkalinity	(CaC03)	123
Carbonate alkalinity	(CaC03)	00
Bicarbonate Alkalinity	(CaC03)	123
Hardness	(CaC03)	115
Free Carbon Dioxide	(C02)	7
Iron	(Fe)	.10
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	.00
Silica	(Si02)	15
Calcium	(Ca)	44.8
Magnesium	(Mg)	0.75
Bicarbonate	(HC03)	150
Sulfate	(S04)	5
Carbonate	(C03)	.00
Fluoride	(F)	.10
Sodium & Potassium as	(Na)	9.90
pH value		750
Total dissolved solids		221
Specific conductance @ 25° C.		275

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.

[signature]

To: US Corps Engnr.
Box 919
Chas., SC 29402
ATTN: MR GH FRANKLIN

PARKER LABORATORY, INC.

40 BROAD STREET
P. O. BOX 791
CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 35170

COMPOSITE SAMPLE

Date : July 29, 1980

Water sample submitted by : US Corps of Engineers, marked: dewatering well at power house, St. Stephens, SC, sample #2, July 23, 1980.

		PARTS PER MILLION
Turbidity	(N.T.U.)	1.50
Color		5
Chloride	(Cl)	6
Total Alkalinity	(CaC03)	122
Carbonate aikalinity	(CaC03)	00
Bicarbonate Alkalinity	(CaC03)	122
Hardness	(CaC03)	115
Free Carbon Dioxide	(C02)	8
Iron	(Fe)	.08
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	.00
Silica	(Si02)	15
Calcium	(Ca)	44.80
Magnesium	(Mg)	0.75
Bicarbonate	(HC03)	149
Sulfate	(S04)	4
Carbonate	(C03)	.00
Fluoride	(F)	.10
Sodium & Potassium as	(Na)	9.80
pH value		7.5
Total dissolved solids		220
Specific conductance @ 25° C.		275

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.

To: US Corps Engnrs.
Box 919
Chas., SC 29402
MR G.H. FRANKLIN

PARKER LABORATORY, INC.

40 BROAD STREET

P. O. BOX 791

CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 35262

Date : 8/12/80

Water sample submitted by : US CORP. ENGNR, marked: de-watering well at power house St. Stephen, SC, Aug. 1980, sample #1-C.

		PARTS PER MILLION
Turbidity	(N.T.U.)	1.0
Color		10
Chloride	(Cl)	6
Total Alkalinity	(CaC03)	140
Carbonate alkalinity	(CaC03)	00
Bicarbonate Alkalinity	(CaC03)	140
Hardness	(CaC03)	130
Free Carbon Dioxide	(C02)	6
Iron	(Fe)	.10
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	.00
Silica	(Si02)	15
Calcium	(Ca)	50.8
Magnesium	(Mg)	0.73
Bicarbonate	(HC03)	171
Sulfate	(S04)	.00
Carbonate	(C03)	.00
Fluoride	(F)	.10
Sodium & Potassium as	(Na)	8.55
pH value		7.60
Total dissolved solids		237
Specific conductance @ 25° C.		306

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.

To: US Corp. Engner.
Box 919
Chas., SC 29402

ATTN: MR. G. H. FRANKLIN

PARKER LABORATORY, INC.

40 BROAD STREET
P. O. BOX 791
CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 35263

Date : Aug 12, 1980

Water sample submitted by : US Corp. Engnr. marked: de-watering well, power house, St Stephen, SC, August 1980, sample #2-C.

		PARTS PER MILLION
Turbidity	(N.T.U.)	7.4
Color		30
Chloride	(Cl)	6
Total Alkalinity	(CaC03)	120
Carbonate alkalinity	(CaC03)	00
Bicarbonate Alkalinity	(CaC03)	120
Hardness	(CaC03)	135
Free Carbon Dioxide	(C02)	7
Iron	(Fe)	1.00
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	.00
Silica	(Si02)	20
Calcium	(Ca)	52
Magnesium	(Mg)	1.20
Bicarbonate	(HC03)	146
Sulfate	(S04)	35
Carbonate	(C03)	00
Fluoride	(F)	.20
Sodium & Potassium as	(Na)	12.80
pH value		7.50
Total dissolved solids		254
Specific conductance @ 25° C.		340

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.

To: US Corp. of Engnrs.
Box 919
Charleston, SC 29402

ATTN: Mr. G. H. FRANKLIN

PARKER LABORATORY, INC.

40 BROAD STREET
P. O. BOX 791
CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 36899

Date : 2/9/81

Water sample submitted by : Composite--US Corps of Engnr., project DACW-60-79-C-0010.
Inspector: Mike Brown

		PARTS PER MILLION
Turbidity (NTU)		4.3
Color		10
Chloride	(Cl)	6
Total Alkalinity	(CaC03)	145
Carbonate alkalinity	(CaC03)	0
Bicarbonate Alkalinity	(CaC03)	145
Hardness	(CaC03)	134
Free Carbon Dioxide	(C02)	1
Iron	(Fe)	.12
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	0
Silica	(Si02)	26
Calcium	(Ca)	49.6
Magnesium	(Mg)	2.4
Bicarbonate	(HC03)	177
Sulfate	(S04)	4
Carbonate	(C03)	0
Fluoride	(F)	0
Sodium & Potassium as	(Na)	10.9
pH value		8.2
Total dissolved solids		250
Specific conductance @ 25° C.		310

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.,

To: US Corp. Engnr.
Box 919
Chas., SC 29402
MR LINCOLN BLAKE

PARKER LABORATORY, INC.

40 BROAD STREET
P. O. BOX 781
CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 36901

Date : 2/9/81

Water sample submitted by : US Corps of Engnrs., marked: De-watering well #2-C, project DACW-60-79-C-0010 , inspector: Mike Brown

		PARTS PER MILLION
Turbidity	(NTU)	2.0
Color		5
Chloride	(Cl)	6
Total Alkalinity	(CaC03)	144
Carbonate alkalinity	(CaC03)	0
Bicarbonate Alkalinity	(CaC03)	144
Hardness	(CaC03)	132
Free Carbon Dioxide	(C02)	4
Iron	(Fe)	.18
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	0
Silica	(Si02)	24
Calcium	(Ca)	48.8
Magnesium	(Mg)	2.4
Bicarbonate	(HC03)	176
Sulfate	(S04)	4
Carbonate	(C03)	0
Fluoride	(F)	0
Sodium & Potassium as	(Na)	11.3
pH value		7.8
Total dissolved solids		249
Specific conductance @ 25° C.		310

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.,

To: a
US Corp of Engnrs.
Box 919
Chas., SC 29402
ATTN: MR LINCOLN BLAKE

PARKER LABORATORY, INC.

40 BROAD STREET

P. O. BOX 791

CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 36900

Date : 2/9/81

Water sample submitted by : US Corps of Engnrs. marked: De-watering well #1-D project DACW-60-79-C-0010, inspector: Mike Brown

PARTS PER MILLION

Turbidity	(NTU)	1.1
Color		10
Chloride	(Cl)	8
Total Alkalinity	(CaC03)	150
Carbonate alkalinity	(CaC03)	0
Bicarbonate Alkalinity	(CaC03)	150
Hardness	(CaC03)	144
Free Carbon Dioxide	(C02)	4
Iron	(Fe)	.09
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	0
Silica	(Si02)	24
Calcium	(Ca)	54.0
Magnesium	(Mg)	2.2
Bicarbonate	(HC03)	183
Sulfate	(S04)	4
Carbonate	(C03)	0
Fluoride	(F)	0
Sodium & Potassium as	(Na)	9.8
pH value		7.9
Total dissolved solids		261
Specific conductance @ 25° C.		325

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.,

To: US Corp of Engnrs.
Box 919
Chas., SC 29402
ATTN: MR LINCOLN BLAKE

PARKER LABORATORY, INC.

40 BROAD STREET

P. O. BOX 791

CHARLESTON, SOUTH CAROLINA 29402

Analysis number: 36902

Date : 2/9/81

Water sample submitted by : US Corps of Engnrs., marked: De-watering well #2-D project DACW - 60 - 79 - C - 0010, inspector: Mike Brown

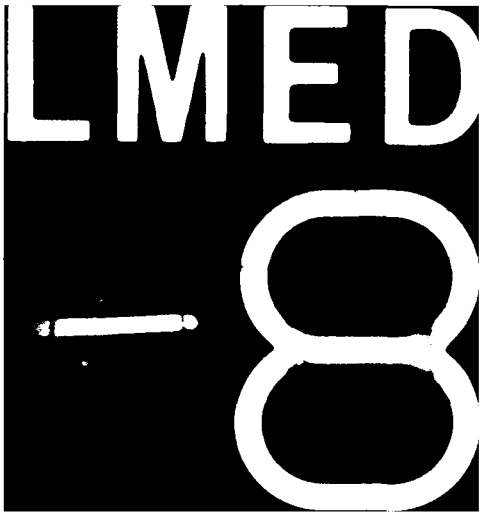
PARTS PER MILLION

Turbidity	(NTU)	1.3
Color		5
Chloride	(Cl)	7
Total Alkalinity	(CaC03)	150
Carbonate alkalinity	(CaC03)	0
Bicarbonate Alkalinity	(CaC03)	150
Hardness	(CaC03)	138
Free Carbon Dioxide	(C02)	4
Iron	(Fe)	.09
Manganese	(Mn)	.00
Copper	(Cu)	.00
Aluminum	(Al)	0
Silica	(Si02)	24
Calcium	(Ca)	52.0
Magnesium	(Mg)	1.9
Bicarbonate	(HC03)	183
Sulfate	(S04)	2
Carbonate	(C03)	0
Fluoride	(F)	0
Sodium & Potassium as	(Na)	11.1
pH value		7.8
Total dissolved solids		258
Specific conductance @ 25° C.		320

REMARKS:

Respectfully submitted,
PARKER LABORATORY, INC.,

To: US Corps of Engnrs.
Box 919
Chas., SC 29402
ATTN: MR LINCOLN BLAKE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